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IDEALS OF CHEMICAL INVESTIGATION[1]

LESS than three centuries ago an outspoken student of nature sometimes faced the grim alternatives of excommunication, imprisonment, or death. To-day he no longer needs to conceal his thoughts in cryptic speech or mystic symbolism. Although the shadow of incomprehensibility may still darken the language of science, mystery is no longer necessary to protect the scientific investigator from persecution. The generally recognized value of the truth with his domain gives him the right to exist.

The courage needful for the task of addressing this august assembly on a topic concerning chemistry is, therefore, of a different order from the courage required for such a task in the days of Galileo. The problem to-day is not how to obscure the thought, but rather how to elucidate its inevitable complications.

Modern chemistry has had a manifold origin and tends toward a many-sided destiny. Into the fabric of this science men have woven the thought of ancient Greek philosophers, the magic of Arabian alchemists, the practical discoveries of artisans and ingenious chemical experimenters, the doctrine of physicists, the stern and uncompromising logic of mathematicians, and the vision of metaphysical dreamers seeking to grasp truths far beyond the reach of mortal sense. The complex fabric enfolds the earth—indeed, the universe—with its far-reaching threads.

[1] Oration delivered before the Harvard Chapter of the Phi Beta Kappa in Sanders Theater, Cambridge, Mass., on June 19, 1916.

The history of the complicated evolution of chemistry is profoundly significant to the student of human thought. Long ago, at the very dawn of civilization, Hindu and Greek philosophers were deeply interested in the problems presented by the nature of the universe. They speculated intelligently, although often with childlike naiveté, concerning energy and the structure of matter; but they forbore to test their speculations by experiment. They builded better than they knew; their ancient atomic hypothesis, ardently supported but very inadequately applied two thousand years ago, now finds itself installed in the innermost recesses of chemical theory. Independently, ancient artisans and medieval alchemists, dealing with the mysterious actual behavior of things, acquired valuable acquaintance with simple chemical processes. After much chemical knowledge of facts had been gained, alchemy sought the aid of philosophy. Thus, little by little, order was brought into the chaos of scattered experience. But strictly chemical knowledge alone was inadequate to solve the cosmic riddle; it had to be supplemented by knowledge of heat and electricity—agencies which produce profound alterations in the chemical nature of substances. Thus the study of physics was combined with that of chemistry. Again, since mathematical generalization is essential to the study of physics, this discipline also was, of necessity, added to the others. All these powerful tools taken together having failed to penetrate to the ultimate essence of things, imagination is invoked, and physiochemical dreams to-day conceive a mechanism of infinitesimal entities far beyond our most searching powers of direct observation.

Chemistry has not grown spontaneously to its present estate; it is a product of human mentality. The science which we know to-day is but an echo of the eternal and incomprehensible "music of the spheres," as heard and recorded by the minds of individual men. Impersonal and objective although matter and energy may be, their appreciation by man involves much that is subjective. The history of science, like all the rest of human history, is, as Emerson said, "the biography of a few stout and earnest persons."

Robert Boyle, self-styled "the skeptical chymist," a gentle spirit skeptical only of the false and vain, pure-minded aristocrat in an age of corruption; Mikhail Lomonosoff, poet, philosopher, philologist and scientific seer, far outstripping contemporary understanding; Antoine Lavoisier, whose clear mind first taught man to comprehend, after thousands of years, the mighty stolen gift of Prometheus; John Dalton, Quaker peasant, who found convincing chemical evidence for the ancient atomic hypothesis; Michael Faraday, a blacksmith's son, whose peerless insight and extraordinary genius in experiment yielded theoretical and practical fruits beyond the world's most daring dreams—these men and a few score others are the basis of the history of chemistry. The science has not come into being, Minerva-like, full-grown from the brain of Jove; she has been born of human travail, nursed and nourished from feeble infancy by human caretakers, and she sees the universe to-day through human eyes.

The diversified origin of chemistry has shaped the varied contemporary application of the science and its many-sided destiny in the years to come. Chemistry has wide theoretical bearings, but at the same time is concerned with the crudest and most obvious affairs of manufacture and every day life. Chemical knowledge must form an essential part of any intelligent philosophy of the nature of the universe, and alone can satisfy one manifestation of that intense intellectual curiosity which to-day, no less

than of old, yearns to understand more of the fundamental nature of things. On the other hand, rational applied science to-day must follow in the footsteps of the swiftly advancing strides of theory. The laws of chemistry can not be adequately applied until they have been discovered. Chemical insight, concerned with the intimate changes of the substances which are all about us as well as within our bodies, furnishes us with the only means for employing material things to the best advantage. Chemical processes appertain in large degree to medicine, hygiene, agriculture and manufacture; these processes depend upon laws of which the perfect understanding is essential to the full development of most of the activities of civilized life.

However oblivious we may be of the inexorable laws of chemistry, we are ever under their sway. Our consciousness is housed in a mortal shell, consisting primarily of compounds of less than a score of chemical elements. The physiological behavior of our bodies is inevitably associated with the chemical changes or reactions among highly intricate chemical unions of these few elements. The driving tendency or immediate cause of the reactions which support life is to be found in the chemical affinities and respective concentrations of the several substances. Our bodies are chemical machines, from which we can not escape except by quitting our earthly life. The nature of the chemical elements and their compounds therefore presents one of the most interesting and important of all problems offered to mankind. That the study of chemical problems of life is consistent with the study of man in a biological, a psychological, or a spiritual sense is obvious. To-day the epigram, "The proper study of mankind is man," must be greatly broadened in order to correspond with modern knowledge.

These words regarding the origin and significance of chemistry serve as an introduction. Your committee has honored me by the request that I should tell you something about the object and outcome of my own endeavors, and these could be made clear only by reviewing the peculiar nature of chemistry. In my case the incentive to the pursuit of science was primarily that intense curiosity concerning the nature of things which echoes down the ages from the time of the ancient philosophers. To the feeling of curiosity, as time went on, was added the perception that only through a knowledge of the fundamental laws of chemistry can men use the resources of the world to the best advantage. Any further gain in this knowledge must, sooner or later, directly or indirectly, give mankind more power. Even an abstract chemical generalization must ultimately be of priceless service to humanity, because of the extraordinarily intimate relation between theory and practise.

The field is wide, and it is traversed by many paths. Among these one must be chosen and persistently followed if progress is to be made; and in my case that one was the study of the fundamental attributes or properties of the chemical elements, and the relation of these properties to one another. The work was undertaken with the hope of helping a little to lay a solid foundation for our understanding of the human environment.

What, now, are the fundamental attributes of the elements? First and foremost among these stands *weight*—the manifestation of the all-pervading and mysterious force of gravitation possessed by all forms of matter. Hand in hand with this attribute of weight goes the equally inscrutable property of inertia—that tendency which causes a body once in motion to keep on moving forever in the same straight line, if

not acted upon by some new force. The idea of inertia, conceived by Galileo and amplified by Newton, was one of the starting points of both modern philosophy and modern physics. So far as we know, weight and inertia run parallel to each other. Of any two adjacent bodies, that having greater weight has also greater inertia. Hence they may be determined at one and the same time, and this Siamese-twinlike conjunction of properties establishes itself at once as perhaps the most fundamental of all the attributes of matter. Next perhaps comes volume, the attribute which enables matter to occupy space, with the corollaries dealing with the changes of volume caused by changes of temperature and pressure. Other fundamental properties are the tendency to cohere (which has to do with the freezing and boiling points of the liquids) and the mutual tendency of the elements to combine, almost infinite in its diversity, which may be measured by the energy-changes manifesting themselves during the reaction of one substance with another.

These are only a few of the important properties of the elements, but they present an endless prospect of further investigation, in spite of all that has been done during the past hundred years. For as yet we know only the surface of these things, and comprehend but little as to the underlying connections between them and the reasons for their several magnitudes. Why, for example, should oxygen be a gas, having an atomic weight just four times as great as that of helium, and why should it have an intense affinity for sodium and no affinity whatever for argon or fluorine? No man can answer these questions; he can discover the facts, but can not yet account for them. The reasons are as obscure and elusive as the mechanism of gravitation. But we shall not really understand the material basis upon which our life is built until we have found answers to questions of this sort.

In order to correlate the properties of the elements, and to attain any comprehension of their significance, one must first exactly ascertain the facts. Therefore, my endeavor has been to institute systematic series of experiments to fill the gaps in our knowledge of the actual phenomena. In much of this work I have had the invaluable aid of efficient collaborators, for which I am grateful.

The atomic weights were the first of the fundamental properties of the elements to receive attention in carrying out this plan. These, as every one who has studied elementary chemistry knows, represent the relative weights in which substances combine with one another. They are called atomic weights rather than merely combining proportions because they can be explained satisfactorily only by the assumption of definite particles which remain indivisible during chemical change. Even if some of these particles or so-called "atoms" suffer disintegration in the mysterious processes of radioactive transformation, the atomic theory remains the best interpretation of the weight-relations of all ordinary chemical reaction. Indeed, it is entrenched to-day as never before in man's history.

The determination of atomic weights is, primarily, a question of analytical chemistry—a question of weighing the amount of one substance combined with another in a definite compound—but its successful prosecution involves a much wider field. First, the substances must be prepared and weighed in the pure state, and next, they must be subjected to suitable reactions and again weighed with proof that in the process nothing has been lost and nothing accidentally garnered into the material to be placed on the scale pan. These requirements involve many of the principles of the

new physical chemistry, so that the accurate determination of atomic weights really belongs as much in that field as in the field of analytical chemistry.

At Harvard during the last thirty years the values of the atomic weights of thirty of the most frequently occurring among the eighty or more chemical elements have been redetermined. From data secured here and elsewhere is compiled an international table of atomic weights, revised from year to year by an authoritative committee composed of representatives of various nations. The values thus recorded are in daily use in every chemical laboratory throughout the world, serving as the basis for the computation of countless analyses performed by the analytical chemist, whether for technical or for scientific purposes.

This practical utility of atomic weights, although not forgotten, was not the prime incentive in the work under discussion. The real inspiration leading to the protracted labor of revising these fundamental quantities was the hope of finding some clue as to the reasons for their several magnitudes, and for the manifest but incomprehensible relationships of the elements to one another.

The unsolved cosmic riddle of the meaning of the atomic weights may have far-reaching significance in another direction, because the atomic weights may be supposed to hold one of the keys to the discovery of the mechanism of gravitation. The mutual attraction of the earth and sun, for example, must be due to the countless myriads of atoms which compose them, each atom possessing, because of its own appointed relative atomic weight, a definite if infinitesimal gravitational force attracting other atoms. If we could discover the reasons for the individual atomic weights, we should probably gain a far better understanding of the all-embracing force built up of the infinitesimal effects represented by their individual magnitudes.

Among the striking facts to be considered is the constancy of gravity (and, therefore, of the sum total of the weights of all the atoms concerned) as shown in many ways. Moreover, not only is the sum total of the weights of the atoms remarkably constant, but also in many cases the values for the individual elements are found to be numbers of amazing constancy. Silver from all parts of the world and from many different ores yields always the same value; copper from Europe has the same atomic weight as the native metal mined under the bottom of Lake Superior; and yet more wonderful, the iron which falls from the sky, in meteorites having their birth far beyond the terrestrial orbit, has precisely the same atomic weight as that smelted in Norway. Many atomic weights, therefore, must be supposed to be constant, whatever the source of the elements.

Although thus we know only one kind of copper and iron and silver, evidence has recently been discovered which points towards the existence of at least two kinds of metallic lead. Every sample of *ordinary* lead always has exactly the same atomic weight as every other sample; but lead from radioactive minerals—lead which seems to have come from the decomposition of radium—has neither the same atomic weight nor the same density as ordinary lead, although in many of its properties, including its spectrum, it seems to be identical. This recent conclusion, reached only two years ago at Harvard, has been confirmed in other laboratories, and it now seems to be beyond question. Whatever may be the ultimate interpretation of the anomaly, the solution of this cosmic conundrum must surely give us a new idea of the essential nature of matter. Indeed, the fascinating subject of radioactivity bids

fair to give us in many ways an entirely new insight into the innermost structure of the atom.

During the progress of the study of the combining proportions of the elements, it became more and more evident to me that the atomic weights should be considered not only in relation to one another, but also in relation to many other essential distinguishing properties of the elements. This wider problem involved a great extension of the experimental field.

Among other attributes of the various forms of matter, compressibilities, surface tensions, densities, dielectric constants, heats of reaction and electromotive forces have begun to receive attention, and already many new data have been accumulated. The explanation of the nature of these researches would take us far beyond the scope of this present address, but their object deserves attention. This object is the correlation of the various properties into a consistent whole, in the hope of tracing the unknown physical influences which determine the nature of the elements.

The rigorous science of thermodynamics enables us to predict in logical and precise fashion some of the relations between physical properties. My hope is not only to aid in providing accurate experimental basis for calculations of this kind, but also to achieve the correlation of different properties, apparently independent of one another from a thermodynamic point of view, thus, perhaps, enabling one by inductive reasoning to penetrate further into the causes which lie back of all the attributes of matter.

In attempting to follow this inductive path comparisons of the properties of the elements have been made in two different ways.

On the one hand a given property of one element has been compared with the same property of another. For example, the question, "Which of the two elements, cobalt or nickel, has the heavier atom?" was answered by parallel determinations, using the same methods, conducted side by side in the laboratory. Cobalt was found to possess the higher atomic weight.

On the other hand, the attempt has been made to discover a relation between the different, apparently quite distinct, properties of a single element. For example, one may ask: "Have the low melting and boiling points of phosphorus any connection with its small density and its large compressibility?" Here one compares various properties of the same element, and one seeks to discover if all are based upon some common, ultimate characteristic of phosphorus, of which the properties are merely symptoms.

The inductive methods used in comparisons of this sort can not be explained here to-day. They are partly statistical, partly mathematical and partly graphical. From the nature of the problem, which involves many unknown variables, perfect mathematical exactness is not to be expected. Nevertheless, little by little, one may hope to trace the conflicting tendencies, and ascribe them to a few common causes.

With the help of these methods the tentative conclusion has been reached that the space occupied by the atom and molecule in solids and liquids is highly significant. The actual atomic bulk or volume is diminished but slightly by moderate mechanical pressures, and by cooling even to the absolute zero; but it is very greatly affected, apparently, by the mutual attractions of the atoms, called cohesion and chemical affinity. Usually the less volatile a substance (that is to say, the more firmly it is held together by cohesion) the greater is its density and the less is its compressibility, other things being equal. Greater cohesion is associated

with greater compactness. Likewise the existence of powerful chemical affinity between elements forming a compound is usually associated with great decrease in volume during the act of combination, and consequent increase in the density of the product in relation to the average density of the constituents. Thus we can hardly escape the inference that both cohesion and affinity, by pulling the atoms together with enormous pressure, actually exert a compressing effect upon the atoms, or at least upon the space which they demand for their occupation. The result of each of these compressing agencies is found to be greater the greater the compressibility of the substances concerned—a new evidence of the reasonableness of the inference. Not always are these effects easily traced, because the situation is often complicated, and the several effects are superposed. Nevertheless, enough evidence has been obtained to leave but little doubt, at least in my mind, as to the manner of working of the essential agencies concerned.

But we need not dwell upon this tentative hypothesis. Many more data and much more thought are necessary to establish it in an impregnable position, although no important inconsistency has thus far been pointed out in it. At present it may be looked upon as valuable because it, like other hypotheses of this type, has stimulated thought and experiment concerning the fundamental facts with which it deals.

As the years go on, the recent contributions to the study of atomic weights and volumes and other properties will be sifted and tested; and such contributions as may stand the test of time will take their places among the multifarious array of accepted chemical facts, laws and interpretations accumulated by many workers all over the world.

But we may well ask: What use, in the years to come, will mankind make of this knowledge gained step by step through the eager study of many investigators?

Chemistry has, indeed, a many-sided destiny. A mere catalogue of the countless applications of the science, which underlies many other sciences and arts, would demand time far exceeding the limits of this brief discourse. Some of the more obvious uses of chemistry have become daily topics in the public press. America is gradually awakening to the consciousness that, because every material object is composed of chemical elements and possesses its properties by virtue of the nature of these elements, chemistry enters more or less into everything. We perceive that chemical manufactures must be fostered, and also that chemical knowledge must be applied in many other industries not primarily of a chemical nature. Although chemistry plays so prominent and ghastly a rôle in war, her greatest and most significant contributions are towards the arts of peace. Even explosives may be highly beneficent; they may open tunnels and destroy reefs, furthering friendly communication between men; dig ditches for irrigation; help the farmer in his planting; and in many other ways advance the constructive activities of mankind. Again, poisonous gases, confined and harnessed within safe limits, may render valuable aid to humanity in preparing precious substances otherwise unattainable.

Such obvious and well recognized offices of chemistry need no further presentation to this intelligent company. Neither is it necessary for me to call your attention to the services which science may render to agriculture through the chemical study and enrichment of the soil in preparing it for the development of those subtle chemical mechanisms called plants, upon which we depend for our very existence.

There is a further beneficent possibility

worthy of more than passing mention—namely, that which arises from the relation of modern chemistry to hygiene and medicine. Already your attention has been called to the indisputable fact that the human body is, physiologically considered, a chemical machine. For this reason, future knowledge of chemical structure and of organic reaction may perhaps revolutionize medicine as completely as it was revolutionized by the devoted labors of Pasteur—not by doing away with his priceless acquisitions of knowledge, but rather by amplifying them. Chemistry may show how germs of disease do their deadly work through the production of subtle organic poisons, and how these poisons may be combated by antitoxins; for both poisons and antitoxins are complex chemical substances of a nature not beyond the possible reach of chemical methods already known. In that far-off but not inconceivable day when the human body may be understood from a chemical standpoint, we shall no longer be unable to solve the inscrutable problems which to-day puzzle even the most learned hygienist and physician. Is not a part, at least, of the tragedy of disease a relic of barbarism? A race which could have put as much energy and ingenuity into the study of physiological chemistry as mankind has put into aggressive warfare might have long ago banished many diseases by discovering the chemical abnormalities which cause them.

May not the study of subtler questions, such as the nature of heredity, also lead us finally into the field of chemistry in our search for the ultimate answer? Even psychology may some time need chemical assistance, since the process of thinking and the transmission of nervous impulse are both inextricably associated with chemical changes in nervous tissue; and even memory may be due to some subtle chemical effect. In the realm of thought there can be no question of the blessed service already performed by science in dispelling grim superstitions which haunted older generations with deadly fear.

In brief, more power is given mankind through the discoveries of chemistry. This power has many beneficent possibilities, but it may be used for ill as well as for good. Science has recently been blamed by superficial critics, but she is not at fault if her great potentialities are distorted to serve malignant ends. Is not this calamity due rather to the fact that the spiritual enlightenment of humanity has not kept pace with the progress of science? The study of nature can lead an upright and humane civilization ever higher and higher to greater health and comfort and a sounder philosophy, but that same study can teach the ruthless and selfish how to destroy more efficiently than to create. The false attitude toward war, fostered by tradition and by the glamor of ancient strife, is doubtless one of the influences which have held back mankind from a wider application of the Golden Rule.

There is, in truth, no conflict between the ideals of science and other high ideals of human life. With deep insight, a poetic thinker on life's problems, in the opening lines of a sonnet, has said:

Fear not to go where fearless Science leads,
Who holds the keys of God. What reigning light
Thine eyes discern in that surrounding night
Whence we have come, . . .
Thy soul will never find that Wrong is Right.

Our limited minds are confined in a limited world, with immeasurable space on all sides of us. Our brief days are as nothing compared with the inconceivable æons of the past, and the prospect of illimitable ages to come. Both infinity and eternity are beyond our mental grasp. We know that we can not hope to understand all the

wonders of the universe; but, nevertheless, we may be full of hope for the future. Step by step we gain in knowledge, and with each step we acquire better opportunity for improving the lot of mankind, and for illuminating the dark places in our philosophy of nature. Although we shall none of us live to see the full development of the help which science may render to the world, we rejoice in the belief that chemistry has boundless service still in reserve for the good of the human race.

THEODORE W. RICHARDS
HARVARD UNIVERSITY

THE ONE HUNDREDTH ANNIVERSARY OF THE U. S. COAST AND GEODETIC SURVEY[1]

THE honor of being one of the speakers on this memorable occasion is highly appreciated, in spite of a perfect realization of the fact that it comes to me solely because I have had the fortune, good or bad, to survive my predecessors. To live long, according to a well-known proverb, is to prove that one is not a favorite of the gods; on the other hand, to live long is to furnish fairly good evidence that one has not been found guilty of a capital crime.

During the past two days the various activities of this service have been so thoroughly discussed by competent critics that there is little room for further comment. As I am, in a way, representing the men who directed these activities during the century of its existence, I choose to speak, not for them, but of them, the superintendents of the Coast and Geodetic Survey, with some reference to their share in the development of the work.

To the republic of Switzerland American science is enormously indebted. Thence came Agassiz, Guyot, Lesquereux, and others who stirred us into scientific activity fifty years ago, and more than a half century earlier came Ferdinand Hassler, organizer and first superintendent of the Coast Survey. No brief sketch can do justice to Hassler's personality or to his all-powerful influence in molding the character of the new organization, the first of the so-called "scientific bureaus" of the United States government. Educated in the best schools of Europe, intimately acquainted with the most eminent scientific men of the Old World and with experience in the trigonometrical survey of his native country, he possessed exactly the qualifications necessary to a successful launching of the new enterprise. Not the least of these qualifications was one rather rare among men of science, though common enough in the so-called "learned professions." With intellectual power and technical skill of the highest order he combined an equally high appreciation of his own merits. It is related that when invited to organize and direct the survey of the coasts, which had been strongly recommended to Congress by Thomas Jefferson, he demanded and received a salary equal to that of the head of the department to which the new bureau was assigned. *Tempora mutantur!* There is also a tradition that when the President objected, saying, "Your salary is as large as that of my Secretary of the Treasury, your superior officer," he replied: "Any president can make a Secretary of the Treasury but only God Almighty can make a Hassler."

Visiting Europe to purchase the necessary instruments and standards of measure, he was detained in England as an alien enemy until 1815 and thus a period of nearly ten years elapsed between its authorization by act of Congress and the actual inception of the Survey.

Hassler's plan of organization, broad and thoroughly worked out, is still the funda-

[1] Address given at the banquet, April 6, 1916.

mental directing ordinance of the Coast Survey. He provided for the division of its operations into three great groups, the geodetic, the topographic and the hydrographic, and of these he considered the geodetic the most important as affecting the accuracy and final value of the results. In insisting upon a degree of precision in the execution of these operations hitherto undreamed of in this part of the world, he "set the pace" which the Survey has since maintained with such distinction and which it must continue to maintain if its future is to be worthy of its past.

Naturally a man of his temperament was likely to come into occasional conflict with government authorities who were quite unable to appreciate the nature and demands of such a service. The very refinement in measure and computation which was the chief merit of the work came near being the undoing of Hassler as it has, indeed, of more than one of his successors. In 1842 a congressional committee made a searching and unfriendly investigation of the Survey, during which, as one of its members confessed on the floor of the House, it was found that of the subject under consideration the superintendent knew so much and the inquisitors so little that the committee was helpless in his hands. Although the work of this committee, like that of most of its successors, was an inquisition rather than an investigation, its report was practically a complete endorsement of the principles on which the Survey had been conducted by Hassler. His death occurred in the following year, but not before a complete and comprehensive plan for the continuation and expansion of the work had been outlined and approved by Congress.

The duty of executing this plan, of building upon the foundation laid by Hassler, fell to one who was everywhere acclaimed as the best fitted for the task.

Alexander Dallas Bache had inherited through his grandmother, the famous "Sally Bache" of the Revolutionary period, only daughter of Benjamin Franklin, not only his distinguished ancestor's tastes for scientific pursuits, but also much of his tact and skill as a diplomat, a quality that contributed in no small degree to his notable success as superintendent. After graduating from West Point Military Academy at the age of eighteen years, at the head of his class, with the extremely rare record of having completed the entire course without having received a single demerit, he had enjoyed a wide experience in public service in various capacities, besides being actively engaged in important researches in magnetism and electricity.

At the age of thirty-seven years he had already won distinction as a scientific man of originality and power and his appointment as Hassler's successor was recommended by all of the principal scientific societies and institutions of learning in the country. His service extended over a period of almost exactly a quarter of a century, being terminated by his death in 1867. The splendid superstructure which Bache erected upon Hassler's foundation has received the highest praise from competent judges in all parts of the world.

During his administration he was successful in securing the confidence of Congress and the operations of the Survey were greatly extended. While keeping well in mind the practical results, for the attainment of which the organization was created, he had a keen eye for the purely scientific by-products of which he gathered a great harvest. The distinguished mathematician and astronomer, Professor Benjamin Peirce, on assuming office as his successor, said of the Coast Survey at the end of its first half century: "What it is Bache has made it. It will never cease to be the admiration of the scientific world. It is only necessary conscientiously and faith-

fully to follow in his footsteps, imitate his example and develop his plans.''

During the later years of Bache's administration Professor Peirce had directed the longitude operations of the Survey, acting also as a sort of general scientific adviser and naturally his policy after becoming superintendent was essentially that of his predecessor. Many of the larger operations of the Coast Survey had been suspended during the Civil War, in which both the superintendent and his assistants had played an important part. The execution of the primary triangulation on both the east and west coasts was resumed by Peirce and an exploration and survey of the newly acquired territory of Alaska was begun. The most important act of his administration was the development of a plan for two gigantic chains of triangles extending across the continent, thus covering the whole country by a trigonometrical survey and joining the systems of the Atlantic and Pacific coasts. This scheme received the approval of Congress and was in many respects the most remarkable work of its kind ever undertaken by any government.

Peirce had continued to hold his professorship in Harvard University and also his many other activities, as a writer of text-books, a frequent contributor to scientific journals, etc., and at the age of sixty-five years, doubtless finding his burden too heavy, resigned the superintendence of the Survey in 1874, after a service of seven years, but he continued to act for a time as ''consulting geometer.'' As a genius in mathematics and astronomy he is easily the star of first magnitude in the Coast Survey galaxy.

Peirce's successor was Carlile Pollock Patterson, naval officer and son of a naval officer.

Previous to his appointment as superintendent he had served for more than a dozen years as hydrographic inspector, an appointment usually held by a naval officer, active or retired.

The general plans of the Survey as perfected by his predecessors were adhered to by Patterson, whose term as superintendent covered a period of seven years, ending with his death in 1881.

His successor, Julius Erasmus Hilgard, was brought at the age of ten years from his birthplace in Germany by his father, a highly educated and successful lawyer and jurist in his own country, who settled on a farm in Illinois near the city of St. Louis. Educated by his father, young Hilgard at the age of eighteen years went to Philadelphia to study to be a civil engineer. There he soon attracted the attention of Professor Bache, who invited him to become one of his assistants in the Coast Survey. In 1845 he joined the corps, his connection with it terminating on his resignation in 1885 after forty years of service. His industry and rare talents brought rapid promotion and in 1862 he became assistant in charge of the office in Washington, a position next in importance and responsibility to that of superintendent. In this capacity he served for nineteen years until his appointment as superintendent in 1881. In the meantime his reputation had become international. He was one of the most influential members of the International Metric Commission that met in Paris in 1872; was made a member of its permanent committee and on the organization of the International Bureau of Weights and Measures, with headquarters at Paris, he was offered the directorship. This honor he declined. By training, ability and experience Hilgard was more completely fitted for the headship of the Coast Survey than any other person who has ever served in that capacity and it was unquestionably the goal which he had hoped to reach.

Recommended for the appointment as Bache had been forty years earlier, by

scientific men, learned societies, colleges and universities, he began his administration under the most favorable conditions. During the earlier years his work justified the confidence reposed in him, but in the meantime, unknown to his friends and perhaps unsuspected by himself, he had become the victim of an insidious disease which weakened the power of both his will and his intellect. Undoubtedly advantage was taken of this fact by others and an investigation of the affairs of the Survey brought to light certain irregularities in its business management that were at first believed to reflect upon the integrity of not only the superintendent, but of many of the older assistants, especially those employed in the field. The superintendent resigned in 1885 and a long and brilliant career thus ended in almost a tragedy.

The investigation referred to was made by a committee of three employees of the Treasury Department with Frank Manley Thorn, chief clerk of internal revenue, as chairman.

Mr. Thorn was placed temporarily in charge of the Survey, and afterwards by appointment of the President he continued to act as superintendent until the close of the first Cleveland administration. The unprejudiced historian can not fail to accord to Mr. Thorn great credit for the way in which he managed the affairs of the Survey during this trying period. Inspired by a prospect of participating in the spoils of office, a number of witnesses had volunteered testimony that was either grossly misleading or absolutely false, and this had been incorporated in the report of the commission of which he was chairman, along with a severe arraignment of the business methods of the Survey and of the integrity of several of its principal officers. During the nearly four years of his administration he learned much about the methods and requirements of such a service as the Coast Survey of which in the beginning he had been totally ignorant. A man of sterling integrity, he had the courage to revise this report by innumerable additions and annotations, practically vindicating the men against whom charges had been made, most of which were merely technical.

In spite of the unwholesome conditions existing in the beginning of Thorn's administration the operations of the Survey were continued without serious interruption and much important work was accomplished.

A much more regrettable state of affairs prevailed during a considerable period of the administration of General William Ward Duffield, who served as superintendent for about three years following his appointment in the autumn of 1894. Not only was the influence of the spoilsman again paramount, but for some unexplainable reason a number of men were dismissed from the force whose places could not be filled from any source whatever. Men of long and faithful service, whose reputation was international, were lost to the Survey at that time, though a few men afterwards were reappointed. It is charitable to assume that the superintendent, who was by profession a civil engineer with a record of good service in the Civil War, had passed the years of discretion before receiving his appointment. That the paralysis by which the service was then afflicted did not become complete was due entirely to an unwavering loyalty to its best traditions on the part of those who remained.

The historian would gladly pass over these unpleasant episodes, but a due regard for the good name and fame of many individuals involved demands brief reference to them.

I come now to the living, whose connection with the service is quite within the memory of most of those interested, and

of whose work little need be said. There are times when brevity is not only the soul of wit but also the essence of discretion.

Upon Henry Smith Pritchett, astronomer and son of an astronomer, fell the task of making a complete reorganization of the hydrographic operations of the Survey. From the earliest days these operations had been carried on almost entirely by naval officers detailed for that purpose, but during the war with Spain such details became impossible. The difficult problem thus presented was solved with marked success by Pritchett and this reorganization, though but one of many notable things accomplished during his comparatively short term from 1897 to 1900, must be regarded, I think, as the most important act of his administration.

The appointment of Otto Hilgard Tittmann, as successor to Pritchett on the resignation of the latter, was an event predetermined by his long connection with the service, which began in 1867, when he was seventeen years old, and continued without interruption for almost a half century, to his resignation in 1915. Inheriting through his mother the scientific tastes and special talents of the Hilgards, with successful experience in nearly every one of the various operations of the Survey, including many years as assistant in charge of the office and assistant superintendent, his remarkable career ended with the longest term as superintendent since the time of Hassler and Bache. Under his direction the Survey has advanced with great strides and so many important things have been accomplished that it is difficult to select even one for mention in this brief review, but among those of first rank will surely be found his personal and official services in representing the United States on numerous international commissions and boundary tribunals.

I am tempted to overstep the bounds laid down for me, to pay my tribute to the ability, faithfulness and loyalty with which the assistants of the superintendent have almost invariably supported him in the discharge of difficult and often disagreeable duties, and I use the term assistant as including not only those employed in the field, but also the office force; the computers, engravers, printers, mechanicians, clerks, etc., through whose hands all of the work of the field officers must pass before it becomes useful to the public. Without this support the ablest chief could accomplish little or nothing. I would like especially to speak of a few of the veterans of my own time who have passed away; of Whiting who, beginning with Hassler, had served for more than a half century and under every superintendent up to the day of his death; of Davidson, the oracle of the Pacific coast, whose service was nearly as long; of Schott, the severe but just judge at the head of the computing division; of Mosman, Fairfield, Eimbeck, Ogden, Grauger, Preston, Mitchell, Smith, Rodgers and others; it is a long roll but it is a roll of honor in the annals of the Survey. To them, and to many others, happily still living, I owe a debt of gratitude for their loyal cooperation and support.

I desire also to testify to the great importance to the service, of the cooperation of the army and navy, especially in the detail of officers from the army in the early days and from the navy during many years for special duty under the superintendent, to whom they were almost, without exception, unselfishly loyal.

I should like, also, to speak more than briefly of some of the famous men who were at various times attached to the Survey for longer or shorter periods, some of whom in this service laid the foundation of their future careers in which they achieved great distinction; of the great artists, Whistler and Alexander; the great scholars, Agassiz

(rather and son), Ferrel, the two Peirces, Gould the astronomer, and others; of Captain Derby, the "John Phœnix" of the world of wit and humor; of Blake, the inventor, and many others, but in this I may not indulge myself.

If I could summon their spirits from the "vasty deep" I am sure those of the former superintendents who are dead would join with those who are living in congratulating their successor who has recently been charged with the responsibility of directing its operations, on the thoroughly trained and competent corps of assistants who will aid him in carrying the Coast and Geodetic Survey into its second century. But perhaps even more important than these will be the traditions of a hundred years which he will not lightly put aside.

I confess to a feeling of *nausea* in these latter days whenever I hear the word *efficiency*, wrenched as it has been from its original meaning and made to stand for "the greatest possible output in the least possible time." The Survey has often been the object of adverse criticism, based on ignorance of the character of its work, because of the slowness of some of its operations. It is to its everlasting credit that as far as known no one has ever found fault with it for not keeping its work up to the highest standard attainable at the time.

Not "how much?" but "how well?" has been its criterion.

It is only by persistently adhering to standards of quality rather than quantity that it will continue to be as it was in the middle, and still is at the end, of its first century, "the admiration of the scientific world."

T. C. Mendenhall
Ravenna, Ohio

GRANTS FOR SCIENTIFIC RESEARCH

MEDICAL SCHOOLS AND LABORATORIES

(*Continued from Vol. XLIII., p. 681*)

The following list contains such facts as the committee has ascertained regarding the funds which are available for medical research in the United States and Canada.

Bender Hygienic Laboratory, Albany, N. Y. Dr. Ellis Kellert, Director. Income, not exceeding $200; available at discretion of Director.

Harvard University Medical School, Boston, Mass. Dr. E. H. Bradford, Dean. Funds approximately "between $350,000 and $375,000" exclusive of teaching fellowships, many of which are utilized for research.

Massachusetts Homeopathic Hospital, Boston, Mass. Dr. F. C. Richardson, Director. Evans Memorial Department of Clinical Research and Preventive Medicine. Income from fund of $260,000 available.

University of Chicago, Chicago, Ill.

Rush Medical College. Dr. J. M. Dodson, Dean. Appropriations from General Budget.

Otho S. A. Sprague Memorial Institute. Dr. H. Gideon Wells, Director. Approximately $35,000 per annum appropriated for research in medicine, used chiefly in paying salaries of research workers.

Memorial Institute for Infectious Diseases, Chicago, Ill. Dr. Ludvig Hektoen, Director. Income from $2,000,000 devoted to research in infectious diseases.

Northwestern University, Chicago, Ill. Dr. C. W. Patterson, Dean.

James A. Patten Fund for Medical Research. $200,000. Income approximately $10,000. Available in all departments of medical research but used mainly in department of bacteriology and in research on tuberculosis.

James A. Patten Fund for scholarships in medical research. $50,000. Income approximately $2,500. Available under same conditions as above.

Vail Research Fund. $2,000. Income available for a research fellowship.

Western Reserve University, Cleveland, Ohio. Dr. C. A. Hamann, Dean.

Cushing Fund. $170,000. (Cushing Laboratory of Experimental Medicine.) Apparatus Fund $17,000. Payne, Crile Fund $8,000. Hanna Fellowship Fund $12,000.

McGill University, Montreal, Canada. Dr. Francis J. Shepherd, Dean. Douglas Research Fellowship in Pathology. $25,000.

Yale University, New Haven, Conn. Dr. George Blumer, Dean. Francis E. Loomis Fund. $20,000. Up to 1915 interest appropriated chiefly for departments of anatomy, physiology and pharmacology.

Tulane University, New Orleans, La. Dr. Isadore Dyer, Dean. Provision statedly for research in annual appropriations, not over $1,000 per annum.

Columbia University, New York, N. Y.

College of Physicians and Surgeons. Dr. S. W. Lambert, Dean. William T. Bull Memorial Fund. $32,100. Income available for research in surgery. Vanderbilt Clinic Endowment Fund. $115,000.

George Crocker Special Research Fund. Dr. F. C. Wood, Director. $1,441,[illegible]. Income available for cancer research.

Cornell University, New York, N. Y. Dr. W. M. Polk, Dean. Sage Foundation Fund for research in calorimetry in connection with ward patients. Occasional funds contributed for particular research work. There are four research fellowships in medicine.

Rockefeller Institute for Medical Research, New York, N. Y. Dr. Simon Flexner, Director. Endowment Fund 1912, $8,443,450.

University of Pennsylvania, Philadelphia, Pa. Dr. Wm. Pepper, Dean.

Robert Robinson Porter Fellowships in Research Medicine. $600 per annum. To be devoted to "investigation in medical sciences."

Robert M. Girvin Fellowship in Research Medicine. $650 per annum. Purpose similar to Porter Fellowship.

Henrietta Hecksher Fellowship in Medical Research. $500 per annum.

University of Pittsburgh, Pittsburgh, Pa. Dr. Thomas Shaw Arbuthnot, Dean. Mellon Fellowships. (1) $750 per annum. Open to graduates in medicine for research in the department of pathology. (2) $600 per annum for research in electrocardiography with clinical study of diseases of the heart.

Washington University, St. Louis, Mo. Dr. P. A. Schaffer, Dean. Provision for research made in departmental appropriations.

University of California, San Francisco, Calif. Dr. H. C. Moffet, Dean. Hooper Foundation. $50,000 annually for medical research. Approximately $1,000 appropriated annually from budget for research in anatomy, physiology and pathology. Department of medicine, $500 annually. Department of surgery, $800 annually. Department of pediatrics, $600 annually. Department of obstetrics and gynecology, $500 annually. Research position in department of pathology, $1,200 per annum.

Leland Stanford Jr. University, San Francisco, Calif. Dr. R. L. Wilbur, President. Coffin Research Fund for study of Tropical Diseases. Amounts for particular departments included in budget.

University of Toronto, Toronto, Canada. Robert Falconer, President. Medical Research Fund yields $15,000 per annum. Surgical Research Fund yields $1,000 per annum.

CHARLES R. CROSS,
Chairman

THE SECOND NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES

THE Second National Exposition of Chemical Industries will be held at the Grand Central Palace, New York City, during the week of September 25–30, 1916. The Advisory Committee of the Exposition is as follows: Chas. H. Herty, *chairman,* Raymond F. Bacon, L. H. Baekeland, Henry B. Faber, Francis A. J. Fitzgerland, Bernard C. Hesse, A. D. Little, R. P. Perry, Wm. Cooper Procter, E. F. Roeber, George D. Rosengarten, T. B. Wagner, Utley Wedge, M. C. Whitaker and Charles F. Roth and Adriaan Nagelvoort, managers.

The roster of exhibitors includes most of the leading companies doing business with those industries wherein chemistry plays a part. From this list it appears that the exposition is already twice the size of its successful predecessor.

The managers anticipate an even greater number of visitors to attend this second exposition. The chemical and engineering societies that last year had their attention divided with the attractions of the exposition and the engineering congresses on the Pacific coast, have this year united and arranged to hold their annual meetings in New York during and in conjunction with the exposition.

The American Chemical Society will hold its annual meeting during the whole week—the program for the meeting is now being arranged and the committees appointed. The American Electrochemical Society has arranged to hold its meetings the latter part of the week, September 28, 29 and 30. The Technical Association of the American Pulp and Paper Industry is arranging its meeting for this week, and other societies are expected to hold meetings.

The Bureau of Commercial Economics at Washington is again cooperating with the exposition by arranging an elaborate program of motion pictures covering subjects dealing with the industries depending on chemistry. A few of the films that appear on the tentative program are: The match industry, the rubber industry, manufacture of explosives, varnish manufacture, silver mining, mining and manufacturing of iron, making of blotting paper, accident and fire prevention, manufacture and use of fertilizers and manufacture of steel.

SCIENTIFIC NOTES AND NEWS

The dispensary building of the Orthopedic Hospital and Infirmary for Nervous Diseases, Philadelphia, has been formally dedicated to the memory of Dr. S. Weir Mitchell, one of the founders of the institution and for many years head of the hospital staff. At the entrance of the dispensary is a stone tablet on which is inscribed in bronze letters, "S. Weir Mitchell Memorial, Philadelphia Orthopedic Hospital and Infirmary for Nervous Diseases, 1915." A bronze tablet in the main waiting room states that the building is dedicated to the memory of Dr. Mitchell by his friends and patients. The address was delivered by the dean of American surgeons, Dr. William W. Keen, who was a close friend and associate of Dr. Mitchell for a period of more than fifty years.

Attention is called in *Nature* to the fact that on June 24, the Rt. Hon. Henry John Moreton, Earl of Ducie, F.R.S., entered on his ninetieth year, having been born in 1827. He is the senior fellow of the Royal Society in point of election to that body, this dating from 1855. When Lord Moreton, he obtained from the Jurassic limestone of Burford the fossil species of star-fish named by Professor Edward Forbes *Solaster moretoni,* in honor of the finder. In connection it may be mentioned that Sir Robert Palgrave, F.R.S., entered on his ninetieth year in the early part of May, while Sir William Crookes attained the age of eighty-four on June 17.

William Morton Wheeler, professor of economic entomology and dean of the faculty of the Bussey Institution, of Harvard University, and Otto K. O. Folin, Hamilton Kuhn professor of biological chemistry in the Harvard Medical School, were given the doctorate of science at the University of Chicago convocation celebrating its twenty-fifth anniversary.

At the quarter-centennial convocation of the University of Chicago, the honorary doctorate in science was conferred on John M. Clarke, state geologist of New York.

Dr. William H. Holmes, chief of the Bureau of American Ethnology, and Dr. Aleš Hrdlička, of the U. S. National Museum, have been made corresponding associates of the Academia Nacional de Historia of Colombia.

At a meeting of the Texas chapter of the Society of the Sigma Xi, on June 5, Dr. Frederic W. Simonds, professor of geology in the University of Texas, was elected president for the year. Dr. Simonds was one of the first five graduate students elected to membership in the Cornell chapter.

The Yale Chapter of Sigma Xi has elected Professor R. S. Lull, president, and Professor W. R. Longley, vice-president, for the coming academic year.

Dr. Axel Gavelin has been appointed director of the Swedish Geological Survey.

Signor Leonardo Bianchi is a member of the new Italian ministry as a representative of the party he leads—that of the Constitutional Democrats. He is professor of psychiatry in the University of Naples and director of the university clinic for nervous and mental diseases, and it is understood that he will devote himself to hygienic and social problems arising out of the war.

Professor Alfred Stenzel has been placed in charge of a clinic at the hospital of the University of Pennsylvania for the exclusive study of industrial and occupational diseases.

Mr. Francis Harper has joined the staff of the Biological Survey of the U. S. Department of Agriculture.

Dr. Willard J. Fisher, whose withdrawal from the department of physics at New Hampshire College was recently noted in Science, has been appointed honorary fellow in phys-

ics at Clark University for the academic year 1916–17.

THE geologist and geographer T. A. Bendrat is about to start on an expedition to the headwaters of the Orinoco River in Venezuela to explore its sources and the surrounding region.

DR. JULIUS HAYDEN WOODWARD, of New York, professor of diseases of the eye at the New York Post-graduate Medical School since 1908, and director of instruction in ophthalmology since 1913, died at his home on July 2, aged fifty-eight years.

THE Kansas State Board is endeavoring to get the state universities to cooperate in an effort to induce the government to establish a health experiment and research laboratory in connection with each university school of medicine under the United States Public Health Service.

WE learn from *Nature* that the formation by the British Advisory Council for Scientific and Industrial Research of a standing committee on mining, constituted so as to represent both the scientific and industrial sides, has now been completed. The standing committee includes the following members nominated by professional associations: Institution of Mining Engineers: Sir William Garforth, Dr. John Haldane, Dr. R. T. Moore, Mr. Wallace Thorneycroft; Institution of Mining and Metallurgy: Mr. Edward Hooper, Mr. Edgar Taylor; Iron and Steel Institute: Professor H. Louis; the South Wales Institute of Engineers: Mr. W. Gascoyne Dalziel; and the following members appointed directly by the advisory council: Sir Hugh Bell, Bart., Mr. Hugh Bramwell, Lieutenant-Colonel W. C. Blackett, Professor Cadman, Professor Frecheville, Mr. Bedford McNeill, Mr. Hugh F. Marriott, Sir Boverton Redwood, Bart., Mr. C. E. Rhodes. The advisory council has appointed Sir William Garforth to be chairman.

THE California State Board of Health, in cooperation with the University of California, is conducting a state-wide malaria mosquito survey under the supervision of Professor W. B. Herms, consulting parasitologist for the state board and associate professor of parasitology in the University of California, who is assisted by Mr. S. B. Freeborn, instructor in entomology. The work began on May 10, and will continue through the summer. Probably three summers will be required to complete the survey of the entire state. The party travels by automobile, collecting mosquitoes, locating their breeding places, determining the presence or absence of malaria, distributing literature, lecturing and giving information on ways and means for the control of the insects. The Sacramento Valley and the northeastern portions of the state to the Oregon and Nevada state lines have already been covered. Thus far endemic malaria has been found at a maximum elevation of 5,500 feet and the Anopheline carriers have been located. Two or three new species of mosquitoes have been found.

THE second Interstate Cereal Conference was held at the University of Minnesota, University Farm, St. Paul, on July 11, 12 and 13. At this conference there was a discussion of the various phases of cereal research relating to the region of which St. Paul may be considered the center. The program included papers on problems of wheat, oat, barley and flax production in the northwest; the grading of barley and corn; breeding winter wheats for Minnesota; ergot for rye; methods for the eradication of bunt or stinking smut; problems in flax diseases, and a symposium on milling and baking. Two days were devoted to the presentation and discussion of papers. The third day was used in an inspection of the plat work of the Minnesota Agricultural Experiment Station and of one of the local flour mills.

ON August 24, 25 and 26, the third annual conference of the Society for Practical Astronomy will be held at the Bausch and Lomb Observatory in Rochester, N. Y. The president of the society, Mr. Latimer J. Wilson, urges all the members to attend these sessions and extends the invitation to any one interested in astronomy. Papers will be read showing the important work of the society and addresses on optical matters and their relation to astronomical research will be given. The Bausch and

Lomb Observatory is equipped with an 11-inch refractor constructed by the Bausch and Lomb Optical Company. The conference promises to be as successful as that of last year, which was held at the University of Chicago.

The mathematicians of the Scandinavian countries, including Finland, will hold a reunion at Stockholm, from August 30 to September 2. The International Congress of Mathematicians was to have been held there at this time, but European conditions have rendered such a meeting impossible, and this reunion therefore serves as a partial substitute.

Students in the field course in geography at the University of Missouri, at Columbia, will take a waterways tour on the Mississippi River and Great Lakes during August. The tour, commencing at St. Louis, will include the following points: St. Paul, Minneapolis, Duluth, Houghton, Saulte Ste. Marie, Mackinac Island, Parry Sound, Toronto, Niagara Falls, Buffalo, Cleveland, Put-in-Bay, Detroit and Chicago. Work on the trip will consist of studies and lectures on the principal local industries, commerce on the Great Lakes, government improvements and aids to navigation, historic geography of the Lakes and Mississippi regions, and physiographic and geologic subjects. No previous study in geology is required of those desiring to make the trip. The course is open to both men and women whether enrolled in the university or not. Three to five hours' credit will be given to those who make the tour. Those not enrolled in the university will be given credit which will be accepted upon entrance by Missouri or other universities of equal standing.

Impressed by the work of the Army Medical School and the inadequacy of the facilities provided for that work, Drs. John M. T. Finney and Joseph C. Bloodgood, of Baltimore, recently left with the president the following memorandum:

> We are so impressed by the character and importance of the scientific work which is being done there we feel the need of bringing to the attention of yourself and the country the utterly inadequate facilities provided not only for purposes of investigation, but for those of instruction as well. The quarters are unsuited for existing conditions and they will prove still more so in case of any expansion of the service.
>
> We furthermore, from our experience as teachers, believe that the Army Medical School should be in the vicinity of, and closely affiliated with, the newly established Walter Reed Hospital for the benefit of both institutions.

North Carolina was the first state in the Union to recognize the need of geologic surveys within its borders. In 1823 an act of the general assembly authorized the board of agriculture to pay the expenses of "geological excursions" for a period of years, as a result of which several geologic reports on the state were published. South Carolina was quick to follow the example of her sister state and in 1824 established a State Geological Survey, whose geologic report, appearing in 1826, was the first issued under the patronage of any state. Massachusetts and Tennessee early established official Geological Surveys on a much larger scale than those of North and South Carolina, and in 1833 Maryland followed their example. To Maryland also belongs the credit of being the first state to undertake a topographic survey, in which she obtained the cooperation of the Coast and Geodetic Survey. This marks the beginning of the federal and state cooperation in such matters which is now so important in topographic mapping and in the investigation of our mineral resources. Bulletin 465 of the United States Geological Survey, entitled "The State Geological Surveys of the United States," includes a historical report of each state in which there is now a Geological Survey, giving also a sketch of early surveys and an account of the legal designation, organization, laws, appropriations, publications and nature of the work of each individual state. The bulletin is valuable as showing the early recognition of the need and value of basic investigations of our enormous latent mineral wealth.

The University of Nevada has founded in both college and station a department of range management. Nevada contains immense areas too elevated for field agriculture, but perfectly adapted to the grazing of bands of cat-

tle and sheep. The range country in Nevada will never be broken up into farms; it can be used for nothing but range; it presents many unique and interesting problems. These center around the adaptation of grazing methods to the periods of growth and reproduction of the native forage plants with a view to making the fullest use of the range without further injury to the plant life. Mr. C. E. Fleming, Cornell, 1910, formerly of the Forest Service, Grazing Studies, has been chosen to head the new department which ranks as a full professorship in the university. Mr. Fleming has been in charge of the Federal Grazing Reserve at Jornada, New Mexico. Studies of the poisonous plants of the range will be carried on by Mr. Fleming and Dr. Jacobson, the head of the department of chemistry in the Nevada station. The project work of the Nevada Experiment Station is being based almost wholly on the problems of western agriculture; an effect is made, however, to maintain the high scientific character and accuracy of the work. The new department will have a set of problems characteristic of the peculiar agriculture of the western mountain country.

THE production of anthracite in 1915, as shown by the final figures compiled by C. E. Lesher, of the United States Geological Survey, from returns made by the operators, was 79,459,876 gross tons, differing from the estimate of 79,100,000 tons published last January by less than one half of 1 per cent. The value of this output was $184,653,498, an average of $2.32 per ton, a value slightly higher than the average in 1914. Compared with the figures for 1914 those for 1915 show a decrease of 2 per cent. in quantity and 1.9 per cent. in value. Anthracite is used mainly as a domestic fuel, and the mild weather during the early months of 1915 resulted in a decrease in consumption. A falling off in the exports to Canada, which normally takes a large quantity, and light buying by householders and retail yards in this country during the summer period of low prices, were also factors contributing to this decrease. There were 176,552 men employed in the anthracite mines in 1915, a greater number than in any year except 1914, when there were 179,679. The average number of days these men worked was 230, as compared with 245 in 1914, and the number of tons produced per man per year was 450, and per man per day 1.96, as against 451 tons per year and 1.84 tons per day in 1914. The smaller number of days worked, together with the comparatively large number of men employed, indicate that the work during the slack months was divided by the companies among a greater number of men than was necessary, in order to assist all. As in 1914, there were few strikes, only 30,325 men having been involved in 1915, for an average of 7 days each. There were 148 machines used in underground mining of anthracite in 1915, and 57 steam shovels were used on the surface, 1,001,431 tons having been taken from steam-shovel pits during the year. The steam shovels are nearly all used in the Schuylkill and Lehigh regions, and the mining machines in the Wyoming region.

GROUND has recently been broken for the building of the Museum of the American Indian in New York City. Mr. Archer M. Huntington has given to the institution a site with a frontage of sixty-five feet on Broadway, just south of 155th Street and adjacent to the group of buildings of which the Hispanic Museum is the center. The plans for the proposed museum provide for a structure with a basement and four stories, which will be in the same style as that of the building of the American Geographical Society. Friends of Mr. George G. Heye, who has gathered the notable collection which is to be placed in the structure, have subscribed $250,000 for the building, and arrangements are now being made to raise the additional $100,000 for the equipment. The collection itself, which includes 400,000 specimens and is valued at $500,000 is to be turned over in a few days to a board of trustees, who are also to take title to the real estate. Marshall H. Saville, of Columbia University, has been the scientific adviser of Mr. Heye for many years, and will be the director of the museum.

AMONG the courses in scientific field work provided for the coming summer quarter by the University of Chicago is one in geology

conducted in the region of Devils Lake, Wisconsin, the area studied covering about 300 square miles. The party is to camp at the north end of Devils Lake, near the center of the area studied, and the field work continues a month. After the field work a report is made, after the general plan of the United States Geological Survey. Another region for field work in geology is to be Ste. Geneviève County, Missouri, where are shown a large number of geological phenomena in a small area, as many as twenty distinct formations being exposed. Collections of fossils from the various formations will be made, which later may be used as the basis for laboratory study at the university. Another area designated for geological study during the summer quarter is that part of the Cascade Range between Mt. Hood and the Columbia River, where may be had first-hand acquaintance with valley glaciers, a great volcanic cone, recent lava flows and the records of at least six geological epochs. This course is open only to men who can "rough it," and the party is to meet at Portland, Oregon, on August 1, for a month's work. A field course is also to be given in the Lower St. Lawrence Valley, one of the most interesting regions geographically in eastern North America, where plain, highland and maritime conditions are often found in close proximity. Scenically also the region is famous, and Montreal, Quebec, French Canada and the eastern provinces afford many opportunities to relate geography to history as well as to present conditions. September will be given to this course and only graduate students can enter it.

UNIVERSITY AND EDUCATIONAL NEWS

At Yale University, Harry Nichols Whitford, B.S., Ph.D., has been appointed assistant professor of tropical forestry in the Forest School, and Alois Francis Kovarik, to be assistant professor of physics in the Sheffield Scientific School.

Dr. Percy Edward Raymond, assistant professor of paleontology in Harvard University, has been promoted to an associate professorship. Dr. Cecil Kent Drinker, of the Johns Hopkins Medical School, has been appointed instructor in physiology in the Harvard Medical School.

At Cornell University, the following promotions to the grade of professor have been made by the trustees: Sidney G. George, C.E., from assistant professor of applied mechanics; Frank O. Ellenwood, A.B., from assistant professor of power engineering; Calvin D. Albert, M.E., from assistant professor of machine design; Albert E. Wells, from assistant professor of machine construction; Lewis Knudson, Ph.D., from assistant professor of botany; Ralph W. Curtis, M.S.A., from assistant professor of landscape art; E. Gorton Davis, B.S., from assistant professor of landscape art.

Four graduate students of psychology have been appointed as fellows for the coming year in the Bureau of Salesmanship Research affiliated with the Carnegie Institute of Technology, as follows: Dwight L. Hoopingarner, of the University of Texas; C. P. Stone, University of Minnesota; Russell L. Gould, Columbia University; Edward S. Robinson, University of Cincinnati. In addition to these appointments, Dr. Kurt Th. Friedlaender, of San Francisco, has received appointment as honorary fellow.

DISCUSSION AND CORRESPONDENCE

RESULTS OF A STUDY OF DOLOMITIZATION

The writer believes that most dolomites were formed in the sea. Facts favoring this view are: (1) Dolomites and limestones are frequently interstratified. (2) Dolomitization is often related to original structures such as bedding, worm borings, etc., but rarely to faults and joints and other secondary structures. (3) Both mineralogical and chemical studies of limestones and dolomites show that limestones free or nearly free from dolomite, and dolomites nearly free from calcite are vastly more common than beds composed of mixtures of limestone and dolomite. If most dolomites had resulted from the action of underground waters, gradations between limestone and dolomite ought to be common. (4) Calcite fossil casts are often embedded in dolomite. Hollow casts are frequently enclosed by perfect dolo-

mite molds. In either case the calcitic shells evidently were deposited in a dolomite ooze. (5) Perfect dolomite rhombs are sometimes embedded in compact, horn-like calcitic beds. (6) Dolomitization bears no relation to the present pore space of beds as it probably would if it had been affected by underground waters.

That replacement was an important process in dolomitization is shown by the bunchy distribution of dolomite in mixed beds of dolomite and limestone, by the invasion of calcitic fossil casts by dolomite rhombs, and by local dolomitization adjacent to or within pervious marine structures, worm borings, shell cavities, etc. Dolomite grains in contact with calcite were all rhombohedral, but had no calcite inclusions. Anhedral form was the rule for dolomite grains in contact with their own kind. Certain facts suggest that dolomitization may take place by direct precipitation near the sea bottom, and by recrystallization of magnesia-bearing skeletons. Proof for the latter processes was not obtained.

Fossils and the shallow water structures of most dolomites show that, like most limestones, they were laid down in shallow warm seas. Salinity seems to have favored dolomitization, since dolomites are common in the enclosed basin deposits. Chemical and mineralogical studies show that dolomites contain isomorphously combined ferrous oxide. This shows positively that dolomites were laid down under reducing conditions.

The writer was able to differentiate calcite from dolomite very successfully with a modified form of the Lemberg solution consisting of 4 grams of fresh $AlCl_3$ crystals, 6 grams extract of logwood, 1,400 grams of water, boiled for 20 minutes with constant stirring and then filtered. Dolomite turns blue in a dilute solution of HCl about 1/10 normal with a few drops of freshly prepared potassium ferricyanide because of its ferrous iron content. Sedimentary calcite in all cases did not show a trace of ferrous iron.

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CELLOIDIN PARAFFIN METHOD

MANY of the difficulties encountered in sectioning hard and brittle objects (chitin, eggs with yolk, etc.) may be overcome by the use of a method which I find is not generally known or used in this country, and which I have been asked to publish in SCIENCE. It is the celloidin-paraffin method of Apáthy,[1] published by him in detail in 1912. Although long, this method combines the advantageous qualities of both the paraffin and celloidin methods, without introducing any disadvantages of either of these methods. There is no shrinkage as in the cooling of paraffin; ribbons can be cut and spread out on the slide by warming as with paraffin; thin sections may be cut even in warm weather, due to the firm nature of the infiltrated celloidin. The method consists of embedding the object in celloidin, clearing and dehydrating the hardened celloidin block, and then infiltrating with paraffin the celloidin block with its contained object. The chief advantage of Apáthy's technique lies in the use of his oil mixture, which is given below.

The method is as follows:

1. Fix, wash and dehydrate material in the usual way, finally putting through three changes of absolute alcohol.

2. Put into a tube of ether-alcohol at least 5 hours, keeping the object high in the tube. (Test tubes of various widths serve nicely for this, the object being held wherever desired by a loose plug of dry cotton wool inserted in the liquid.)

3. Two per cent. celloidin for twenty-four hours, deep in the tube.

4. Four per cent. celloidin for twenty-four hours, deep in the tube.

5. Put object into paper embedding box (or small dish) of four per cent. celloidin, and harden in chloroform vapor twelve hours.

6. Quickly trim excessive celloidin from the object, leaving a few millimeters on each side, and put deep into tube of chloroform for 12 hours.

7. Put into a tube of Apáthy's oil mixture

[1] Apáthy, S., 1912, "Neuere Beitraege zur Schneidetechnik," *Zeitschr. wiss. Mikr.*, Bd. XXIX., S. 449–515, 4 textfiguren.

until the block becomes clear and sinks; this may take from three days to a week. The oil mixture is as follows:

Chloroform by weight	4 parts
Origanum oil by weight	2 parts
Cedarwood oil by weight	4 parts
Absolute alcohol by weight	1 part
Carbolic acid crystals by weight	1 part

Put some dried sodium sulphate into the bottom of the tube to take up the water brought into the mixture by the celloidin.

8. Wash cleared block in three or more changes of benzol; this takes out oils and alcohol, and prepares for paraffin infiltration.

9. Infiltrate in paraffin, and embed. The temperature of the bath and long duration of infiltration will not cause shrinkage, as Apáthy states that blocks left in a bath at 70° C. for a week showed no shrinkage. To insure good ribbons I find a paraffin of medium hardness satisfactory in most cases, and leave a margin of pure paraffin about the celloidin-paraffin block when trimming. Where hard chitin is to be cut and the firmest possible block is desired, I use hard paraffin to infiltrate, and cut with a slanting knife on a sliding microtome.

10. Section and mount, using Mayer's fixative; then spread out and affix by warming as for paraffin sections. In staining on the slide, avoid leaving for any great length of time in xylol or absolute alcohol, as these liquids will dissolve the celloidin. A clearing oil instead of xylol may be used to advantage before the balsam. When objects stained in bulk are used, merely remove the paraffin in xylol and mount in balsam.

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THE ASPHYXIATION OF CANCER

Granting, at the present time, that early surgical removal is the most satisfactory method of curing cancer, there still remains the "hope which springs eternal in the human breast" of the scientist that a day will come when a successful non-surgical treatment of cancer may be realized. For centuries competent investigators have been seeking this goal, but without avail. With the exception of toxic gases, practically all of the possible chemical, physical and biological agents have been tried, including cell poisons, caustics, electricity, heat, light (visible and invisible rays), "vaccines," sera, and cell or organ extracts. The chief difficulty has been the finding of an agent which has a specific destructive action on the cancer cell without an injurious effect upon the surrounding healthy tissues. It must be admitted that a rational non-surgical treatment awaits the demonstration of a specific causal agent, or of a logical explanation of such an abnormality based on a thorough study of the chemistry and physics of protoplasm in general and of the living cell in particular.

A working hypothesis concerning the cause of cancer has been formulated by the writer after several years of theoretical and practical study. According to this hypothesis cancer is the result of localized, unchecked, over-combustion, or hyperoxidation, in epithelial cells; this condition is brought about by the concentrated, accelerated and uninhibited action of intracellular oxidizing enzymes, or their coenzymes, as a result of various injurious agents.

Based upon this theory, a rational treatment of the disease involves the inhibition of such "hyper-oxidations," or the complete asphyxiation of the cancer cells. This may be attempted indirectly by attacking the intracellular oxidizing enzymes (upon which cell oxidations, growth and multiplication so largely depend) or by renewing those enzymes in the body whose function it is to combat injurious cell oxidations. The direct asphyxiation of the cancer cell involves (1) the withholding of oxygen (so necessary for cell life) either by cutting off the blood supply or by absorbing the oxygen itself before it can be of service to the tumor cells; or (2) the introduction of sufficient carbon dioxid, or other toxic gases, to cause the suppression of oxidations in the tumor cells. It is evident that such a treatment must be confined to the cancer cells, for the general effect would be to kill all of the body cells. Herein lies the chief difficulty in its practical application.

Experimental work, involving the above

ideas, is now being carried on—the results of which will form the basis of future communications.

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UNIVERSITY OF NORTH DAKOTA,
April 28, 1916

QUOTATIONS

BUSINESS MEN WHO WANT THE METRIC SYSTEM

NOTHING gives so much hope that the metric system will some day be adopted in America as the work now being done in its behalf by the National Wholesale Grocers' Association. It is their type of support which alone can clinch the case in favor of the simpler standard. The theorists have done their best. They have proved conclusively what saving in time and labor, what gain in foreign trade, would follow upon the adoption of the metric system. Meanwhile, however, the country has been generally given to understand that practical men opposed the change, that they thought it would involve, while it was being made, insuperable difficulties to trade and manufacture. The wholesale grocers are practical men. In countless daily transactions their business would be directly affected by the change; they would have to undergo whatever hardships may accompany the shift in all its early days. And yet the grocers say they want the metric system.

Nor are the grocers content with wanting. They are also doing all they can to hasten the system's adoption, and in the measures they are taking, the country can see what ways may be followed in order to prepare for the change and make it, when it comes, less difficult. In pursuance of a report submitted by a special committee to the convention in Boston, every wholesale grocer is urged to print on the labels of all canned and boxed good not only the weight in English pounds and ounces, but also the metric equivalent. This custom will have two values. It will help to educate the American people in the metric system, and it will begin at once to reap the benefits for American goods abroad, especially in the South American countries, which a general adoption of the metric system promises. Furthermore, the grocers are preparing for their membership complete and easily used tables of equivalents, and are doing their utmost to show how the first year or two of the change might be rendered less difficult by their use.

Psychologically, also, the study which these practical men are making has its value to help explain why the American passion for liberty has never extended to open revolt against slavery to the old English tables. They show that children everywhere are being given a distaste for the metric system by the way it is presented to them in their study of arithmetic. Since the schoolbooks necessarily present it in relation to its equivalents in English weights and measures, it means no more for them than a new instrument of mental torture. Learned for itself alone, it would offer no more difficulty than the American money system gives the boy who learns it in a day, and almost without trying. Harnessed to the old English equivalents, its true simplicity is not revealed. From this poor start in school days, the American public appears to continue in amazing ignorance of the metric system's real value.

Very few men know, says the report to the grocers, what time it would save in commercial arithmetic and very few know the increasing pressure for its adoption brought by the needs of trade with countries which have it. If this be so, then the grocers' committee's proposal, that to their practical efforts there should be added an organization exclusively designed to educate the public on this subject, ought surely to be furthered.—*The Boston Transcript.*

SCIENTIFIC BOOKS

Who is Insane? By STEPHEN SMITH, A.M., M.D., LL.D. The Macmillan Co., 1916.

Not the least remarkable thing about this very readable book is the fact that its author is a nonagenarian. Dr. Smith was the state commissioner in lunacy of New York from 1882 to 1888, and the present work largely embodies his observations during those years, together with the deductions of his long experience concerning the big questions of the prevention and treatment of mental disease.

The word of criticism which might be offered

that some of the clinical cases cited for illustration contain insufficient data to make them entirely convincing, loses some of its force perhaps, when it is recalled that the book is intended primarily for popular instruction, and to that end lapses naturally into the anecdotal style.

The author is delightful in his incorrigible optimism as to the hopefulness of treatment of insanity, crime and feeblemindedness under more rational conditions of organization and classification, and by more scientific methods than have hitherto existed. The general treatment of insanity he considers under three periods corresponding to the three tenses. The past was the period of mechanical restraint. The present is the period of custodial care. The future will be the period, let us hope, of curative treatment. The present, with all its humanitarian ideals and active therapeutic efforts is still the period of custodial care. We must perhaps admit it.

But the author looks ahead to the time when the state hospitals shall no longer be in the main simply repositories for the mentally infirm. He suggests that these institutions should comprise five definitely organized departments: (1) research, (2) curative, (3) industrial, (4) custodial, (5) hospital. The research and curative departments he would have under one administration consisting of an alienist, a physiologist, a pathologist, and a psychologist, together with field-workers and such other assistants as might be required. The plan as outlined is admirable, and already partially operative in many institutions. But Dr. Smith's forecast culminates in an ultra-optimism. "Might not the per cent. of 'discharged as cured' from our asylums be raised from twenty-five or thirty-three per cent. to eighty or ninety per cent., if all the resources of science, art and humanity were brought into requisition immediately on admission of each person legally committed as insane?" In the author's discussion it might seem that the environmental factors, important as they are unquestionably, are stressed too much, or rather that the endogenic factors are insufficiently stressed.

Excellent is the author's insistence upon the value of the work-cure in mental disease, and of the work-habit as prophylaxis, maintained onward into old age. "Retirement from business at this period, to enjoy the fruits of a life of toil, is to turn one's face towards the cemetery to which he will hasten with ever quickening step."

The nonagenarian physician evidently practises his own gospel, for now at ninety-three comes from his pen a book full of valuable and interesting material and fruitful suggestion, reflecting the youthful spirit of hopefulness and progress, rather than the retrospective sadness of a less efficient old age.

C. B. Farrar

Beekeeping. By E. F. Phillips, Ph.D. Rural Science Series. New York, Macmillan & Co. Pp. xxii + 457. 190 figs. Price $2.00.

We are living in an age of applied science; but the student of animal behavior is perhaps little concerned with the possible application of his branch of scientific inquiry. On this account the author's fundamental conception and mode of treatment are of particular interest. Beekeeping is applied animal behavior. As the author suggests, the well-informed beekeeper probably has a wider and more accurate knowledge concerning bees than have many students of animal behavior concerning the species with which they work. The successful beekeeper is, as we are told, the man "who has a knowledge of the activities of bees, whereby he can interpret what he sees in the hives from day to day, and who can mould the instincts of the bees to his convenience and profit." In this volume, therefore, the bee is treated as a living animal and special stress is laid upon its behavior and physiology in so far as investigations have thrown light upon these processes.

The United States Department of Agriculture is singularly fortunate in having as its chief expert in bee culture one so well fitted by the character of his training as Dr. Phillips, who has approached, from the standpoint indicated above, a subject which is perhaps more liable than most branches of agri-

cultural activity to be governed by individual preferences than by methods based on definite scientific principles. This is well illustrated in the case of the wintering of bees, which constitutes one of the most important questions for the practical beekeeper, particularly in the more northerly regions. As a result of the elaborate investigations which the author and his associates have conducted, the activities of the bees in the winter cluster and the factors affecting such activities have been brought out of the darkness, which heretofore, both literally and metaphorically, has hidden them from view, to the light of day so that they can now be described intelligently and the knowledge so acquired can be put to the greatest possible practical use. The fact that the temperature reactions of bees are so strong and so important from the practical standpoint demonstrates the value of the "behavior" point of view.

That a thorough knowledge of the behavior of the bee is essential is indicated by the fact that although bees have been kept by man from time immemorial they have not been domesticated; they have not, as Langstroth maintained, been tamed, but their natural instincts have remained unmodified. Consequently, the beekeeper must direct their instincts along the lines best adapted to his own ends. It is to the credit of American beekeepers that they have been so successful in this line of effort, for although it is undoubtedly true that, up to within recent years, the scientific knowledge of bees has been largely due to the work of European investigators, commercial beekeeping on a large scale is, as the author claims, "an American institution." The development of practical beekeeping began with the invention of the movable frame hive by Langstroth, the father of American beekeeping (1810–1895), and a comparison of the prevailing type of American hive, which is simple and useful for work, with the more elaborate British hive is significant.

All the important lines of work in the management of bees are fundamentally dependent upon a knowledge of their behavior. Honey production is the beekeeper's object, consequently he must so manipulate his bees that, when the nectar is available near his apiary, the bees may be in a condition to secure the maximum quantity. In this connection he should also possess some knowledge of the nectar-producing plants occurring in his neighborhood and in the localities in which he establishes his "out apiaries," and the period of their flowering, for this reason an annotated list of considerable length of nectar-producing plants is given and constitutes a valuable section of the book.

Ever since Dzierzon announced his theory that the drone is a product of an unfertilized egg, parthenogenesis in the bee has afforded both beekeepers and scientific workers a theme for much disputation. In beekeeping the question is of no little practical significance, especially to the breeder. The conclusion of Dr. Phillips on this point is of value, as he has devoted particular attention to the problem of parthenogenesis for a number of years. He does not feel that Dzierzon's conception that all the eggs in the ovary of the queen are male eggs is correct, but thinks that it is not improbable that the eggs destined to be females, that is, queens or workers according to their post-natal treatment, die for want of fertilization, while eggs destined to be males, not requiring fertilization, are capable of development. In view of what we now know concerning the biochemistry of fertilization the author's suggestion deserves serious thought. In no other insect is the question of sex determination of greater importance since the value of race is as important in beekeeping as in any other form of breeding.

With a few exceptions the existing books on beekeeping are little more than works of reference or books of rules. There was a distinct need for a work that was readable, based on scientific principles and eminently practical. Dr. Phillips has satisfied these requirements to a degree that it would be most difficult to surpass. His work is as admirable in the method of presentation as it is in the well-balanced treatment of all the many aspects of the subject. The illustrations are well chosen,

largely original and advisedly subordinated to the text. The Rural Science Series contains many valuable treatises, and although comparisons *are* invidious, none shows greater evidence of most careful writing in the face of an obvious necessity for compression. Beekeepers, both amateur and commercial, and teachers in agricultural colleges, are under a debt of gratitude to the author of this book; if it does not come to be regarded as the standard handbook on the subject on this continent we shall be greatly surprised.

C. Gordon Hewitt

A VALUABLE UNPUBLISHED WORK ON POMOLOGY

Most horticulturists are doubtless familiar with "A View of the Cultivation of Fruit Trees of America," published in 1817 by William Coxe, of Burlington, N. J., who has been called "The Father of American Pomology," but probably few are aware of the existence of an unpublished book of colored drawings of the fruits that were illustrated in this work by wood cuts. On pages 225–226 of the *Country Gentleman,* of Albany, N. Y., for April 2, 1857, there was published by E[dmund] L[aw] R[ogers], Baltimore, Md., an account of the activities of Mr. Coxe, in which it is stated that he had intended publishing a second edition of the work, accompanied by colored engravings for which natural-size water-color drawings had been prepared by his daughters. The publication of this second edition was prevented by Mr. Coxe's death in 1831. About twenty years ago this article came to the attention of Mr. William A. Taylor, then assistant pomologist of the U. S. Department of Agriculture, and a number of letters were written in an effort to locate the colored drawings, but without success. The matter was then dropped until the spring of 1915 when, in a conversation regarding some old horticultural catalogs, Mr. Taylor related these facts to the writer who suggested that it might still be possible to locate the unpublished colored plates through methods used by genealogical research workers.

The search was begun by looking up at the Library of Congress historical and genealogical works which might give information regarding the descendants of William Coxe, with the result that a list of his children was obtained, with some of their marriages. From this it was learned that Philadelphia and vicinity was at present the most likely locality to search for his descendants. Addresses were obtained of several of the Coxe family in that vicinity and a form letter sent to all of them giving the object of the inquiry, with the result that a chart of this branch of the family, only recently published, was secured by the writer. This gave the names of all descendants to date, but without addresses, although the places of births were usually given. With this clue several city and telephone directories were consulted and addresses of most of the descendants obtained. About twenty-five copies of the form letter were then sent to these addresses with the almost immediate result of six replies giving the address of the probable possessor of the work, followed the next day by a letter from one of the twenty-five addressed acknowledging the possession of the work.

It is with great pleasure that announcement is made of the donation of the unpublished colored drawings of fruits to the Library of the U. S. Department of Agriculture by the grandchildren of Mrs. Elizabeth (Coxe) McMurtrie, a daughter of William Coxe, by whom most of the paintings were made. The drawings are bound and in an excellent state of preservation. The character of the work shows a high degree of skill on the part of the artist in depicting fruits; and the positive identification of all the earlier descriptions and illustrations, some of which have long been in doubt, will now be possible. The work has been placed in a fireproof building and it is expected that the additional safeguard of a fireproof safe for this and similar books will be provided at an early date.

The drawings are accompanied by the bound manuscript upon which the published work was based, to which have been added numerous notes intended for a second edition. Many of

the notes bear dates ranging from 1810 to 1828 and it probable that the water-color work was largely done in the early part of this period, for several varieties are illustrated which according to the manuscript did not live long, or were destroyed as being of little value or particularly subject to disease.

In this connection it may be of interest to pathologists to call attention to early records which the manuscript and drawings contain relating to plant diseases, some of which were not described or apparently were but little known at that time to botanists or mycologists, and one of which at least was not recognized until fifty years later. There were few mycologists in this country or Europe at that early period and many diseases were not of sufficient economic importance to attract their attention. In fact most of the growers, if they paid any attention to fruit spots at all, considered them a part of the fruit. Many of the diseases now well known were doubtless of common occurrence even then, and perhaps much earlier. Microscopes of any decided magnification were then unknown, and scientists of those days can hardly be blamed for failing to make such observations.

In Coxe's published work of 1817 but one disease is mentioned, the fire blight of the pear (*Bacillus amylovorus* (Burr.) De Toni) which evidently then as now was a serious disease towards the eradication of which but little progress apparently has been made in the 100 years which have followed. In the season of 1915 which was unusually wet, this disease swept over a large part of the apple-producing section of the country, doing great damage to the trees. Stevens and Hall state[1] that this has been known over 100 years. It is probable that much earlier records could be found by the examination of older literature. The organism that causes the blight was not described until 1888.

In the unpublished colored drawings and the manuscript accompanying them are found descriptions or very accurate colored illustrations of the following fungous diseases:

[1] Stevens, F. L., and Hall, J. G., "Diseases of Economic Plants," 101, 1910.

Leaf Blight (*Fabræa maculata* (*Lev.*) *Atk.*).—The species was first issued in exsiccati by Léveillé in 1843 as *Entomosporium maculatum* and described somewhat later. The characteristic fruit spots are well depicted on both the pear and apple.

Pear Scab (*Venturia pyrina Aderh.*).—This was for many years confused with the apple scab and was not separately described until 1896.

Apple Scab (*Venturia inæqualis* (*Cooke*) *Winter*).—This was first described under *Sphærella* by Cooke in 1871.

Flyspeck of Apple (*Leptothyrium pomi* (*Mont. & Fr.*) *Sacc.*).—This was first described under *Labrella* in 1834. The sooty blotch (*Phyllachora pomigena* (Schw.) Sacc.) according to Duggar is only one stage of the flyspeck, and was first described by Schweinitz under *Dothidea* in 1832. Both are well illustrated on a number of varieties of apples.

Bitter Rot (*Glomerella rufomaculans* (*Berk.*) *Spauld. & Von Schrenk*).—This was first described by Berkeley under *Septoria* in 1854. Spaulding and Von Schrenk did not discover an earlier reference to the disease. In the Coxe manuscript under date of May 30, 1829, the bitter rot is referred to as common, with the statement that the author had been told by John Hoskins the elder that slaked lime was a good remedy for the disease. In accordance with this suggestion he spread a peck of slaked lime around each of 21 apple trees and worked it into the soil. No notes were made as to results, owing to his early death.

Fruit Spot (*Cylindrosporium pomi Brooks*). This disease is well illustrated on several varieties of apples and has been identified beyond question by Mr. Brooks. The disease was first discovered by Brooks in 1896. He states that it was first reported in Germany by Sorauer in 1879 and in this country by Jones in 1891. It was evidently not previously distinguished from the bitter rot.

Peach Scab (*Cladosporium carpophilum Thüm.*).—This was first described by von Thümen in 1879.

Probably other fungi are figured on the vari-

ous fruits but none that can be identified with accuracy.

A reference is also made in the manuscript to worms around the roots of peach trees which are said to cause an exudation of gum. This probably refers to the larvæ of some boring insect. An attempt was made to get rid of them by applying a handful of salt around the roots once or twice a season with the only result, however, that the larvæ were more numerous after the application than before.

P. L. Ricker

Bureau of Plant Industry

SPECIAL ARTICLES

THE INVERSION OF MENTHONE BY SODIUM, POTASSIUM AND LITHIUM ETHYLATES, AND A METHOD OF ANALYSIS FOR METHONE IN PINE OILS

The work of Tubandt[1] has shown that the reaction

$$l\text{-menthone} \rightleftarrows d\text{-menthone}$$

can be followed polarimetrically, is monomolecular and is catalyzed by acids and bases. The present study has involved the measurement of the velocity of the inversion when brought about by sodium, potassium and lithium ethylates in absolute ethyl alcohol at 25°; a special constant temperature bath, holding silver-plated copper polarimeter tubes, has been employed.

The molar constant, K_N, found for the activity of the three ethylates at dilutions ranging from $N/32$ to $N/512$, were substituted in the equation $K_N = K_i\alpha + K_m(1-\alpha)$, derived by one of us[2] to express the activity of both the non-ionized molecules and the ions of a reacting electrolyte, and gave series of satisfactory constants for the activity of both the ethylate ions, K_i, and the non-ionized molecules K_m, of each ethylate.

It was found that the constant expressing the activity of the ethylate ion was the same, whether calculated from the data for sodium, potassium or lithium ethylate: for $NaOC_2H_5$, $K_i = 0.501$; for KOC_2H_5, $K_i = 0.501$, and for $LiOC_2H_5$, $K_i = 0.496$. The constants for the reactivity of the non-ionized ethylate were found to be very nearly the same for sodium and potassium ethylates, but somewhat lower in the case of lithium ethylate, as has been found to occur with other reactions. Thus, for $NaOC_2H_5$, $K_m = 0.693$; for KOC_2H_5, $K_m = 0.701$, and for $LiOC_2H_5$, $K_m = 0.478$.

The relative magnitudes of these constants agree with the fact that the molar constant, K_N, drops off with dilution for sodium and potassium ethylates, but does not change with dilution in the case of lithium ethylate; that the molar constants for sodium and potassium ethylates are close to one another in value, but different from those for lithium ethylate; and, finally, that the reaction velocity constants become practically the same for all three ethylates in the very dilute solutions in which the metallic ethylate is nearly completely ionized.

Having shown above that sodium, potassium and lithium ethylates cause the inversion of menthone, it was thought important to use this as an analytical method to determine the presence of menthone, and its amount, in certain pine oils said to contain the levo form of this material. Eight per cent. absolute alcoholic solutions of pine oil and of several of its fractions were made. These contained also N/64 sodium ethylate. These solutions showed no appreciable change in optical rotation in about three hours. In order to prove that no *l*-menthone was present in the pine oil an alcoholic solution containing 2 per cent. of partly inverted *l*-menthone and 8 per cent. of the same pine oil, or of its fractions, and $N/64$ sodium ethylate, was found to give the usual change in rotation observed for alcoholic solutions of *l*-menthone. It is clear, then, that pine oils have no appreciable influence on the change of rotation of admixed *l*-menthone and that the amount and rapidity of change of rotation by a given concentration of sodium, potassium or lithium ethylate can be used as a measure of the amount of *d*- or *l*-menthone in pine oil in excess of any amount of the equilibrium mixture of *d*- and *l*-menthone. If there is an excess of *l*-menthone present its effect on the rotation may be offset by other constituents hav-

[1] *Ann.*, 339, 41, 1904.

[2] *Am. Chem. Jour.*, 48, 359, 1912.

ing an opposite rotation. For example, *l*-borneol acetate with a specific rotation of —44.4° could yield ethyl acetate and borneol with a specific rotation of —37.8° *l*-menthol acetate, with a specific rotation of —79.4°, yields *l*-menthol having a specific rotation of —50°. The change of rotation in these two cases is in the same direction as that of *l*-menthone and would be added to it. In other cases, however, the changes might be in the opposite direction. The change in rotation due to the borneol acetate, for example, can be calculated from the ester number, which is always determined, and the proper correction can be made.

The same idea can be applied to the calculation of the amounts of each of two esters whose identities are known and whose changes of rotation by sodium ethylate are different or of opposite sign. The ester number and change of rotation will give the amount of each. When the mixtures become complex the "unknowns" become too large and the method becomes only qualitative at best.

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MEASURING BIOLOGICAL ACTIONS BY THE FREEZING-POINT METHOD DIRECTLY IN THE SOIL

IT has already been shown that the freezing-point method can be employed to measure (*a*) the concentration of the plant-cell sap directly in the plant tissue,[1] (*b*) the concentration of the soil solution at different moisture contents, directly in the soil,[2] and (*c*) the effect of application of soluble chemical compounds upon the soil solution.[2] In the present note it is desired to announce that the freezing-point method can be used also to study biological activities, by measuring the products of decomposition of organic materials, directly in the soil.

In conjunction with the experiments on the effect of the application of soluble chemical compounds upon the concentration of the soil solution, the effect of the decomposition of various nitrogenous substances was also studied. It has been found that the products of decomposition of these nitrogenous substances increased markedly the concentration of the soil solution, and the magnitude of the increase varied with the nature of the compound and amount employed. In the following table there are presented the results of a single experiment which might serve to typify the character of the general data obtained. This experiment consisted of mixing 0.5 and 1.0 grams of dried blood, cotton-seed meal and animal tankage with 800 grams of soil (equivalent to about 1,250 and 2,500 pounds per 2,000,000 pounds of soil respectively), allowing the mixture to stand in room temperature for five weeks at optimum moisture content and then determining the freezing-point depression, according to the method already described in Tech. Bull. No. 24 of this Station. The percentage of nitrogen contained by the materials is as follows: dry blood, 14.14 per cent.; cotton-seed meal, 7 per cent., and animal tankage, 10 per cent.

TABLE I

Effect of Decomposition of Nitrogenous Substances Upon the Freezing-Point Depression of the Soil Solution

Substance	Grs.	Depression Due to Substance
Dry blood	0.5	.025° C.
" "	1.0	.050°
Animal tankage ...	0.5	.020°
" " ...	1.0	.040°
Cotton-seed meal ...	0.5	.017°
" " " ..	1.0	.030°

The depression in every case is the difference between the depression of the untreated soil or check and that of the treated. In other words, the check was used as a standard.

It will be seen then that the decomposition of these nitrogenous materials increased the depression, and hence the concentration of the soil solution, markedly, and the magnitude of the increase seems to vary with the nature of the material and quantity employed.

In some other experiments the amounts of these nitrogenous materials were used, not in equivalent weight but in equivalent nitrogen content and the freezing-point depression was

[1] *J. Am. Soc. Agr.*, Vol. 8, No. 1, 1916.

[2] Tech. Bull. No. 24, Mich. Expt. Sta., 1916.

measured at various intervals. The results show that dried blood reached its maximum decomposition first, followed by animal tankage and cotton-seed meal, respectively.

The study of soil bacteriology at present consists mainly of either measuring the number of bacteria in the soil, or the kind and intensity of functions of the bacteria. The former study is usually designated as *taxonomic* and the latter as *physiological.*

The taxonomic method is at present not much used in the bacteriological studies of soils, because it has failed to furnish very satisfactory results. The physiological method, however, has proven more successful, at least from the practical standpoint, and is consequently more widely employed.

As already stated, the physiological method aims to measure the kind and physiological efficiency of the organisms by measuring the product of their action upon nitrogenous substances. The products resulting from the decomposition of the nitrogenous materials consist principally of ammonia, nitrite, nitrate amino compounds, etc. Unfortunately the present methods for measuring these end products are for the most part unsatisfactory.

From the results obtained thus far by the freezing-point method on the decomposition of organic materials in soil, it seems possible that this method may be used to great advantage in conducting physiological studies. It is true that the method gives only the total amount of the decomposed soluble material and tells nothing as to the composition of the product. But is not the amount of ammonification, nitrification, etc., taken as criterion of the decomposibility of the substance and the physiological efficiency of the organisms? So may the total depression be taken to represent the same criterion. The decomposition products will undoubtedly exert a solvent action upon the mineral constituents of the soil, and thus influence the total depression. There are evidences, however, which go to indicate that this influence is small (aside from the chemical combination) and consequently the error would be comparatively insignificant. On the other hand, the study will be only comparative.

It appears that the freezing-point method may be used to great advantage in making comparative studies of the decomposibility of various organic substances, in the same kind of soil, or the decomposing power of different classes of soil on the same organic substance, or of the same soil differently treated, etc. Such studies can be conducted very conveniently, under the most natural conditions, and the results thus obtained will doubtless lead to very important and true conclusions concerning the availability of various nitrogenous materials, decomposing power of soils, etc.

Studies along these lines are now being conducted in the laboratory.

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THE SYNONYMY OF OXYURIS VERMICULARIS, THE PIN WORM OF THE HUMAN INTESTINE

In 1758 Linnæus described the pin worm of man under the name of *Ascaris vermicularis.* In 1803 Zeder transferred it to the genus *Fusaria* (*Ascaris* renamed). In 1819 Bremser placed it in *Oxyuris* (type *O. equi*). Baird in 1853[1] published a manuscript name of Leach's *Enterobius vermicularis.*

The species has been generally called *Oxyuris vermicularis* until Stiles in 1905 gave it the generic name of *Oxyurias,* overlooking Leach's name. Now Seurat in 1916[2] proposes the name *Fusarella,* evidently being unaware of the generic names it has received subsequent to *Oxyuris.*

The species clearly does not belong in the same genus with *Oxyuris equi,* and as *Enterobius* is the earliest generic name available, the name of the species is *Enterobius vermicularis* (Linnæus, 1758) Leach, 1853.

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1 "Catalogue of the Species of Entozoa, or Intestinal Worms, Contained in the Collection of the British Museum," p. 108.

2 *Compt. rend. Soc. de biol., Par.,* Vol. 79, p. 67.

THE IOWA ACADEMY OF SCIENCE

THE Iowa Academy of Science held its thirtieth annual session with Drake University, Des Moines, April 28 and 29, 1916. In the number of papers presented this meeting exceeded any previous session, a fact which speaks well for the scientific activity of the students and investigators of the state. The academy followed the plan instituted last year of having most of the papers presented before sectional meetings, of which there were three—1, Chemistry; 2, Physics; and 3, Botany, Geology and Zoology.

In the evening of the twenty-eighth Dr. Louis Kahlenberg of the University of Wisconsin gave the annual address before the Academy on "Some Results from the Experimental Study of Osmosis."

The Iowa and Ames sections of the American Chemical Society met with the Academy and an Iowa section of the Mathematical Association of America was organized during the meetings.

The following were the officers elected to serve during the coming year.

President: G. W. Stewart, State University.

First Vice-president: L. S. Ross, Drake University.

Second Vice-president: Miss Alison E. Aitchison, State Teachers College.

Secretary: James H. Lees, Iowa Geological Survey.

Treasurer: A. O. Thomas, State University.

PROGRAM

Abstracts are by the authors

Barium in Tobacco and Other Plants: NICHOLAS KNIGHT.

A number of samples of tobacco were examined and a small quantity of barium found in each one. The samples were obtained from Sumatra, Cuba and from various sections of the United States. Thirteen samples of leaves of common trees were also examined, and a sample of the soil in which they grew.

Pure Sodium Chloride: NICHOLAS KNIGHT.

Samples of common salt were made by four different methods, and small amounts of potassium chloride were found in each sample. Similar results were obtained from three samples of "C.-P." sodium chloride.

Some Rock Analyses: NICHOLAS KNIGHT.

An Improved Method of Determining Solubility: W. S. HENDRIXSON.

Acid Potassium and Sodium Phthalates as Standards in Acidimetry and Alkalimetry, II.: W. S. HENDRIXSON.

Some Auxoamylases: E. W. ROCKWOOD.

Electromotive Forces and Electrode Potentials in Pure and Mixed Solvents, II.: F. S. MORTIMORE and J. N. PEARCE.

The Behavior of Solutions at the Critical Temperature, a Preliminary Report: PERRY A. BOND.

A Comparison of Barbituric Acid, Thiobarbituric Acid and Malonylguanidine as Quantitative Precipitants for Furfural: A. W. DOX and G. P. PLAISANCE.

An Accurate Aeration Method for Determining Alcohol in Fermentation Mixtures: A. W. DOX and A. R. LAMB.

Relative Influence of Bacteria and Enzymes on Silage Fermentation, Preliminary Report: A. R. LAMB.

Estimation of Calcium in Ash of Forage Plants and Animal Carcasses: S. B. KUZIRIAN.

The Pleasant Ridge Group of Effigy Mounds: ELLISON ORR.

These mounds are included in the proposed Mississippi Valley National Park. This park will include a strip of land along the bluffs from a point about six miles south of McGregor, Iowa, to the mouth of Yellow River, about three miles north of McGregor. This group of mounds lies on a very high point of the bluff about half way between McGregor and the mouth of Yellow River, and is comprised of some eight or nine animal mounds and three bird mounds, all in a good state of preservation.

An Old Roman Coin in South Dakota: DAVID H. BOOT.

Contributions to the Geology of Southwestern Iowa: GEORGE L. SMITH.

A Note on Fulgurites from Sparta, Wisconsin: W. D. SHIPTON.

A New Stratigraphic Horizon in the Cambrian System of Wisconsin: W. D. SHIPTON.

Records of Oscillations in Lake Level, and Records of Lake Temperature and Meteorology Secured at the Macbride Lakeside Laboratory, Lake Okoboji, Iowa, July, 1915: JOHN L. TILTON.

Tidal effects were almost zero, barometric effects too small to be detected without magnification, and intake and outflow about equal. Wind effects were noticeable and quickly compensated by movement in the lake. The wind directed the circulation in the lake. The division of the lake water into

epilimnion, thermocline and hypolimnion was pronounced, even after strong winds. Evaporation amounted to about two tenths inch per twenty-four hours. Rainfall caused an immediate rise in the hydrograph.

The Mollusca of the Loess of Crowley's Ridge, Arkansas: B. Shimek.

A discussion of the fauna of the loess of this ridge, with a list of species.

Superimposition of Kansan Drift on Sub-Aftonian Drift in Eastern Iowa: Morris M. Leighton.

During the reconstruction of the C. M. & St. P. Ry., new cuts were recently opened up in eastern Iowa, in the vicinity of Delmar Junction, showing a body of sub-Aftonian drift beneath Kansan drift. A soil zone, together with a mineralized stump and fragments of wood, separate the two drifts. The Aftonian interval is recorded also by several feet of leaching of the lower till which is in contrast to the calcareous portions of the overlying till.

These exposures are of unusual importance to the Pleistocene geology of Iowa in that they show that the sub-Aftonian ice-sheet as well as the Kansan invaded eastern Iowa, and they throw light upon the data of the superimposition of certain major streams in eastern Iowa.

Pleistocene Exposures on Capitol Hill: James H. Lees.

The area made classic in Pleistocene geology by the studies of McGee and Call is now exposing to even better advantage the relations of Wisconsin drift, pre-Wisconsin loess and Coal Measures. No pre-Wisconsin drift is present. Fifteen feet of loess, buff except as weathered to gray, is overlain by Wisconsin till, with a zone of mingled loess and fossil-bearing drift between. A great lens of sand lies within the loess. The possible relations of the strata are discussed.

Progress Report of Geological Work in the Driftless Area: A. C. Trowbridge.

The History of Devil's Lake, Wisconsin: A. C. Trowbridge.

An Outlier of the Clinton Formation in Dubuque County: J. V. Howell.

Describes an occurrence of an oolitic, ferruginous layer at the Maquoketa-Niagaran contact seven miles west of Dubuque, Iowa. The material apparently is identical in lithologic character and stratigraphic position with the "Clinton" ore of eastern Wisconsin, which Savage and Ross have recently shown to be of Ordovician age.

Geological Conditions Regarding Oil and Gas in Southeastern Iowa: George F. Kay.

The Super-Kansan Gumbo of Southern Iowa: George F. Kay.

Progress Report on Studies of the Iowan Drift by the Iowa Geological Survey and the United States Geological Survey: George F. Kay.

Bibliography of the Loess: E. J. Cable.

A Correlation of Peneplains in the Driftless Area: Urban B. Hughes, presented by A. C. Trowbridge.

Major Discissive Lines in Prairie States: Charles Keyes.

Decipherment of the geotectonic features of the Prairie region of the Continental Interior is attended by so many difficulties that little real advance is recorded in a half century. Lately, however, new data on the problems involved became available. Considering alone fault-lines of relatively large displacement the Iowa field affords some unusually instructive information. The great Cap-au-Grès fault is found to extend into Iowa, where its greatest throw is not less than 100 feet. The remarkable Fort Dodge fault with a throw of about 125 feet has economic bearings of high importance. The Red Oak fault has a displacement of more than 350 feet. The famous La Salle fault seems to find expression near Dubuque and elsewhere in the northeastern part of the state. In western Iowa the fault-spacing appears to be quite regular with an approximate value of 25 miles. Recognition of this fact suggests the probable existance of other notable faults of the series and fully explains many hitherto apparently incongruous records regarding the areal distribution of the various terranes of the region.

Wide Areal Extent of Chouteau Limestone: Charles Keyes.

Long prevailing misconceptions concerning the stratigraphic extent and relations of the Chouteau limestone, originally described by G. C. Swallow in central Missouri, and a manifest tendency of late years to disregard the terrane as a useful and valid mapping unit have recently led to a reexamination of the section at the type locality and a careful correlation of the formation as there exposed with other sections east and north. In the latter direction it now appears that the Chouteau limestone retains its characteristic features and relationships to the Minnesota boundary, where, with other Paleozoic terranes, it rises against the old Siouan arch—a Triassic mountain axis of large proportions. Towards the east, by complete thin-

ning out, the Burlington limestone, which immediately succeeds the Chouteau limestone at the original locality is, on the Mississippi River, made to rest unconformably upon the older Hannibal shales.

Cirque Phenomena in British Columbia: CHARLES KEYES.

From the banks of the Skeena River, which flows into the Pacific ocean a few miles below the southernmost point of Alaska, the coast ranges rise abruptly to elevations of 3,000 to 4,000 feet. The snow-line is here sufficiently low to render it easily accessible. Cirque phenomena are developed to a wonderful extent. Perhaps nowhere else in all the world are the various phases so well displayed. The glaciers are in all stages of disappearance, so that on every hand their work is left open to the most detailed scrutiny. Even from the railway train many of the different aspects are easily viewed. For a distance of more than 100 miles the rail journey is interruptedly in the midst of clearly observable cirque phenomena. In few places on the globe are all the details corroborating the Johnson hypothesis of cirque formation so well laid bare.

The Lithogenesis of the Sediments: F. M. VAN TUYL.

There are few lines of investigation in geology which promise more fruitful returns than the lithogenesis of the sediments. The importance of careful study of recent sedimentary deposits both of the continental and marine type as a basis for interpreting the history of the ancient sediments can not be too strongly emphasized, as was pointed out recently by Andrée. Indeed, some of the greatest contributions to stratigraphy have already come through such studies.

It is believed that more careful and systematic examination of the sediments with the aid of the microscope would aid greatly in interpreting the conditions of their deposition as well as the nature of their source. Here lies a great field almost untouched, although its possibilities have been shown by the studies of Sorby, Cayeux, Mackie, Rogers, Goldman and others.

The Western Interior Geosyncline and its Bearing on the Origin and Distribution of the Coal Measures: F. M. VAN TUYL.

Some New Niagaran Corals from Monticello, Iowa: A. O. THOMAS.

The coral reef near Monticello is rich in the more common species of Niagaran corals. Careful collecting extending over a number of years has resulted in the discovery of a few new and instructive species. Among them are several commensals exhibiting some interesting relations. Descriptions and illustrations.

A Highly Alate Specimen of Atrypa Reticularis (Linné): A. O. THOMAS.

Specimens of *Atrypa reticularis* preserving the fragile excrescences about the margins of the shell are uncommon. A fine specimen from the Devonian at Independence, Iowa, illustrates this feature better than any figured in the literature at present, as far as known.

The Effect of Temperature upon the Elasticity of Tungsten: H. L. DODGE.

On the Variation of the Reflecting Power of Isolated Crystals of Selenium with the Azimuth of the Incident Polarized Light: L. P. SIEG.

A Physical Representation of the Summation of Certain Types of Series: L. P. SIEG.

A Study of Some of the Torsional Elastic Properties of Phosphor-Bronze Wires: A. J. OEHLER, introduced by L. P. SIEG.

An Electrical Apparatus for securing and maintaining Constant High Temperatures: W. E. TISDALE.

The Tungsten X-Ray Spectrum: ELMER DERSHEM.

Why Hot-Water Pipes in Household Plumbing burst more frequently than Cold Water Pipes: F. C. BROWN and WALDEMAR NOLL.

A Bibliography of the Literature bearing on the Light Sensitiveness of Selenium and a Statement of Outstanding Problems: F. C. BROWN.

A Curve of Moisture Condensation on Glass Wool: L. E. DODD.

The Stroboscopic Effect by Direct Reflection of Light from Vibrating Membranes: L. E. DODD.

A New Tonoscope: L. E. DODD.

Certain Conclusions in Regard to Audition: G. W. STEWART.

A New Method of Identification of Polarized Light Reflected from Small Opaque Crystals: LEROY D. WELD.

A Sheep's Brain without a Corpus Callosum, a Demonstration: H. A. SCULLEN.

Recent Theories of Heredity in relation to the Theory of Natural Selection: C. C. NUTTING.

The paper discusses briefly the theories of Weismann, Mendel, de Vries and Bateson with the definite contribution of each to our knowledge of heredity, together with its net result as affecting our attitude towards natural selection.

Trophospongium of Crayfish Nerve Cell (illustrated): L. S. ROSS.

"Axone Hillock" of Crayfish Nerve Cell (illustrated): L. S. Ross.

A Malignant Tumor of a Chicken Liver, a Demonstration: L. S. Ross.

Notes on Two Strawberry Slugs: R. L. Webster.

An account of two strawberry insects that have been frequently confused in the literature of economic entomology.

A Method of Preparing Studies of Trichinella spiralis Owen: Dayton Stoner and Thesle T. Job.

Life History and Habits of the Gold-banded Paper Maker, Polistes metricus Say: Frank C. Pellett.

Distributional Notes on Some Iowa Pentatomoidea: Dayton Stoner.

An Hermaphrodite Crayfish: Ivan L. Ressler.

The White Admiral or Banded Purple Butterfly in Iowa: B. O. Wolden.

Notes on the Little Spotted Skunk: B. H. Bailey.

Successful Mink Farming in Iowa: B. H. Bailey.

A Handy Device for Staining Slides: E. Lawrence Palmer.

The simple staining apparatus demonstrated was devised to take the place of the more expensive staining jars sold by most of the scientific supply houses. Besides the cheapness of the outfit, which fits into any tumbler, there is the added advantage that all of the slides being stained may be removed from the jar at once and may be rinsed while still in the frame. Fourteen slides may be inserted into the frame at one time, which is four more than the average staining jar holds.

The device is made by bending eight strips of zinc 15 × 200 mm. into the channels (*a*). These are soldered to the 20 × 140 mm. zinc strip (*b*) which is then bent into a rectangular form with the channels on the inside. The strip (*c*) 1 × 26 cm. is then soldered to the ends of the strip (*b*), forming a handle with which to lift the frame, and a guard to prevent the slides from falling out at the bottom.

This piece of apparatus has proved particularly handy in staining work where most of the slides require the same treatment.

A Seed Key to Some Common Weeds and Plants: E. L. Palmer.

This preliminary key to the seeds and fruits of one hundred and eighteen of the common weeds and plants of northeastern United States uses external characters as a basis for classification and arranges the seeds according to size. Most keys are made on a strict dichotomous plan. In this case, however, those seeds whose length is between 1 and 2 mm., between 2 and 3 mm., etc., are considered separately. After this step, one finds the key on a strict dichotomous plan. The possibility of entering the key at a number of places lessens the number of decisions to be made in determining the individual and consequently increases the probability of correct determination. Besides detailed descriptions of all the seeds mentioned in the key, there are pen and ink sketches of forty-one of the more typical forms considered.

The Growth of Legumes and Legume Bacteria in Acid and Alkaline Media: R. C. Salter.

A Forest Census in Lyon County, Iowa: David H. Boot.

The Preservation of Fleshy Fungi for Laboratory Use: Guy West Wilson.

Notes on some Peliate Hydnaceæ from Iowa: Guy West Wilson.

Scleroderma vulgare and its Allies: Guy West Wilson.

Some Observations on California Plants: L. H. Pammel.

Some Observations on the Weeds of California: L. H. Pammel.

A Record of Fungus Diseases: L. H. Pammel and Charlotte M. King.

How a Tree Grows: Fred Berninghausen.

Notes on the Pollination of Some Plants: Robert L. Post, presented by L. H. Pammel.

Notes on Anatomy of the Leaves of Some of the Conifers of North America: L. W. Durell, presented by L. H. Pammel.

Notes on the Flora of Sitka, Alaska: J. P. Anderson.

Notes on a Cultivated Elodea: R. B. Wylie.

Insect Pollination of Frasera stenosepala: L. A. Kenoyer.

Insect Pollination of Timber Line Plants in Colorado: L. A. Kenoyer.

Pioneer Plants on a New Levee, II.: Frank Thone.

The paper is a condensed summary of late developments on the area discussed in a paper presented at the 1915 meeting of the academy.

The Control of the Oats Smut by Formalin Treatment: J. A. Krall.

Late Blight Epidemics in Iowa as Correlated with Climatic Conditions: A. T. Erwin.

The Sand Flora of Eastern Iowa: B. SHIMEK.

The sandy areas in Muscatine and Louisa counties are chiefly discussed. The number of species peculiar to the sands of this region is small, the greater part of the flora being that of the prairies. Notes on seasonal succession on these areas are included.

The White Waterlily of Iowa: HENRY S. CONRAD.

The paper describes the variations of *Nymphæa odorata,* and gives in parallel columns the distinctions between this species and *Nymphæa tuberosa.* It questions the identification of all the waterlilies from the Great Lake region and the Central States, and asks for fuller study to determine the taxonomic value and the range of these forms.

A Section of Upper Sonoran Flora in Northern Oregon: MORTON E. PECK.

The paper gives first a brief account of the climatic conditions, topography, etc., in the neighborhood of Umatilla, Oregon. The several plant associations, with the areas they cover, are next described. The discussion closes with a complete annotated list of the species of seed plants known to inhabit the area under consideration.

JAMES H. LEES,
Secretary

DES MOINES, IA.

THE KENTUCKY ACADEMY OF SCIENCE

THE Kentucky Academy of Science held its third annual meeting at Lexington, in the lecture room of the physics department, University of Kentucky, May 6, 1916, President N. F. Smith in the chair.

After a business session at which a number of new members were elected, and among other things a resolution was passed favoring the adoption of the bill now before Congress requiring the use of the Centigrade thermometer scale in government publications (H. R. 528), the following program was carried out:

President's Address—Problems and Progress of Twentieth-century Physics: N. F. SMITH.

Twentieth-century physics had its birth in the year 1895, when Roentgen discovered the new form of radiation known as X-rays. There followed rapidly after this a succession of important discoveries chiefly connected with radio-activity. From the many new facts discovered there has gradually developed the electronic theory of matter and electricity. It has been definitely established that every electric charge is made up of an exact number of elementary electric charges or atoms of electricity. The magnitude of this elementary electric charge has been determined with great accuracy. From the value of this elementary charge other important physical constants can be accurately determined, among them the mass of an electron, and the masses of different atoms. It has been shown that every electric current is a convection current; the inertia of matter is probably entirely due to its electrical nature and is analogous to self-induction. It has been shown that X-rays are of the same character as light, but with a wave-length about one-ten-thousandth part as great. This has been established by the use of crystals as a diffraction grating. A reasonable theory of the structure of the atoms of the different elements has been established which is in close agreement with observed facts. The electromagnetic theory, as worked out by Maxwell, is incomplete and requires important modification to account for the facts of radiation. On the whole, remarkable progress has been made in the development of physical theory.

Astronomy Applied in Archeological and Historical Research: HENRY MEIER.

The author had collected a large number of events and circumstances mentioned in works on ancient history and given in ancient Greek or Roman classics, which events referred to a probable total eclipse of the sun or moon taking place about the time given and visible in the regions referred to. He then calculated the times of all possible eclipses for the time and place of each event and having thus established accurately the year, month and day of the event given by history he was enabled to determine with certainty other historic dates related to the event.

Likewise from the accurately measured orientations of certain ancient temples in Upper Egypt dedicated either to the sun or to a well-known star, he determined, based upon the facts that the obliquity of the sun's ecliptic is a variable quantity and that the declinations of fixed stars change from year to year, the probable time of construction of each temple, and thus he was able to fix chronologically the events related through inscriptions in each temple.

Some Historic Fish Remains: ARTHUR M. MILLER.

When the writer took charge of the department of geology, State College, in 1892, he found stored in the basement of the old Chemistry Building, some interesting fossil fish remains. He later found that

the labels pasted on them containing the initials "J. S. N." were placed there by J. S. Newberry and that these were the identical specimens described in Vol. 1, Paleontology of the Ohio Geological Survey, under the names *Orodus* and *Ctenacanthus* from the "Waverly Shale" exposed at Vanceburg, Ky. It was the finding in this deposit of the teeth of the fish which had been named *Orodus* in such close juxtaposition with the spines of the fish which had been named *Ctenacanthus*, that led Professor Newberry to conclude that these two structures belonged to one and the same species.

Reference was made to a previous account of these remains given by Professor Andrews in a volume of the Ohio Survey published in 1870 on work done in 1869, in which these specimens were credited to a Captain James Patterson, who found them in the Upper Black Shale (Sunbury Shale) at Vanceburg, Ky.—presumably in the course of quarrying the shale for oil distillation, an industry started in this country in the fifties or sixties of the last century, but speedily abandoned, when the discovery by Silliman, of Yale, led to the obtaining of paraffin more cheaply from petroleum.

Comment was made in this connection on how paleontology is indebted to commercial operations for some of its more interesting fossil remains.

A New Form of Frequency Meter: N. F. Smith.

A rotating disc marked off in sectors alternately black and white is illuminated by an A. C. arc light. Since the light comes principally from the positive carbon, the illumination of the disc is intermittent. Therefore a stroboscopic effect is produced, and with proper speed of rotation the disc appears to stand still. From the rate of rotation of the disc, the frequency of the current is at once determined.

The Dr. Robert Peter Herbarium of the University of Kentucky: Frank T. McFarland.

The paper shows the value of the Peter Herbarium as compared with the herbarium of the University of Kentucky.

In the University of Kentucky Herbarium are 4,106 specimens, of which 3,157 were collected by Dr. Robert Peter and Dr. Charles W. Short, of Lexington, from 1832 to about 1835. For the state, Dr. Peter has listed a total of 1,205 species, but only 470 mounted species are in the Herbarium. Only 592 species for the state are listed in the University of Kentucky Herbarium, with which the Peter Herbarium is consolidated, much fewer than the actual number in the state.

"Stem Rot" of Alfalfa and Clovers Caused by Sclerotinia Trifoliorum, Erik: Alfred Holley Gilbert.

The paper contains reference to previous observations, as reported in Kentucky Experiment Station Circ. No. 8, 1915; also a brief résumé of the history of the disease in Europe and America, and a report of a recent attack upon crimson clover in Kentucky.

Since the causal organism is a soil fungus and sclerotia may remain in the soil, retaining their vitality, possibly, for several years, a rotation of crops in which no one of the several legumes which serve as hosts for the fungus is grown for at least three years, is recommended as a control measure. The host plants so far as known are all the cultivated clovers and alfalfa. A common weed, *Abutilon*, was also observed to act as a host plant.

On the Distribution of Phosphorus in a Section of Bluegrass Soil: Alfred M. Peter.

Analyses of soil samples from each 6 inches, from the surface to the rock, showed strikingly different percentages of phosphorus, ranging from 0.258 in the second to 6.692 in the twentieth 6 inches, with other maxima in the fifteenth and twenty-fifth 6 inches.

These differences are similar in degree to those existing between different layers of the phosphatic Lexington limestone, and are accounted for by supposing that the calcium carbonate of the limestone has been dissolved away, leaving most of the phosphate in layers of greater or less richness, according as the limestone layers were more or less phosphatic.

Precipitation of Cobalt and Nickel Salts in Gels: C. A. Nash and John Ardery.

The following paper was read by title:

"Note on a Specimen of Radioactive Mineral," by J. W. Pryor.

At the afternoon session Dr. F. R. Moulton, of the University of Chicago, delivered an illustrated lecture on "Some Recent Discoveries in the Sidereal Universe," in which the present methods of determining the distances and motions of the fixed stars were explained in a popular way.

The election of officers was as follows: Professor A. M. Miller, president; Dr. Garnett Ryland, vice-president; Professor P. P. Boyd, treasurer; Dr. A. M. Peter, secretary.

About forty members of the academy were in attendance and a large number of guests.

A. M. Peter,
Secretary